Macintosh

TECHNICAL BULLETIN

Overview: Macintosh IIfx

The Apple® Macintosh® IIfx system, Apple's newest Macintosh computer, incorporates a 40-megahertz 68030 microprocessor, a 32K Static RAM Cache memory subsystem, and a 40-megahertz 68882 floating-point coprocessor for high-speed processing of complex mathematical functions. These features combine to make the Macintosh IIfx three times faster than the Macintosh IIx and twice as fast as the Macintosh IIci.

The Macintosh IIfx also incorporates dedicated I/O (input/output) processors. These custom-designed ASICs (application-specific integrated circuits) boost system efficiency by managing all of the low-level I/O tasks—for the Apple Desktop Bus™, floppy disk drives, and serial ports—that were previously carried out by the 68030 processor. In addition, the Macintosh IIfx contains a dedicated SCSI/DMA (Small Computer System Interface/Direct Memory Access) controller that improves SCSI performance.

System memory can be expanded from 4 to 8 megabytes (and up to 128 megabytes in the future) for high-performance applications that demand superior system responsiveness, and six NuBus™ expansion slots can accommodate a wide range of Apple and third-party expansion cards, such as network interface and graphics cards.

A new Processor Direct Slot (PDS) provides a high-speed interface for third-party hardware options. Six external interface ports accommodate
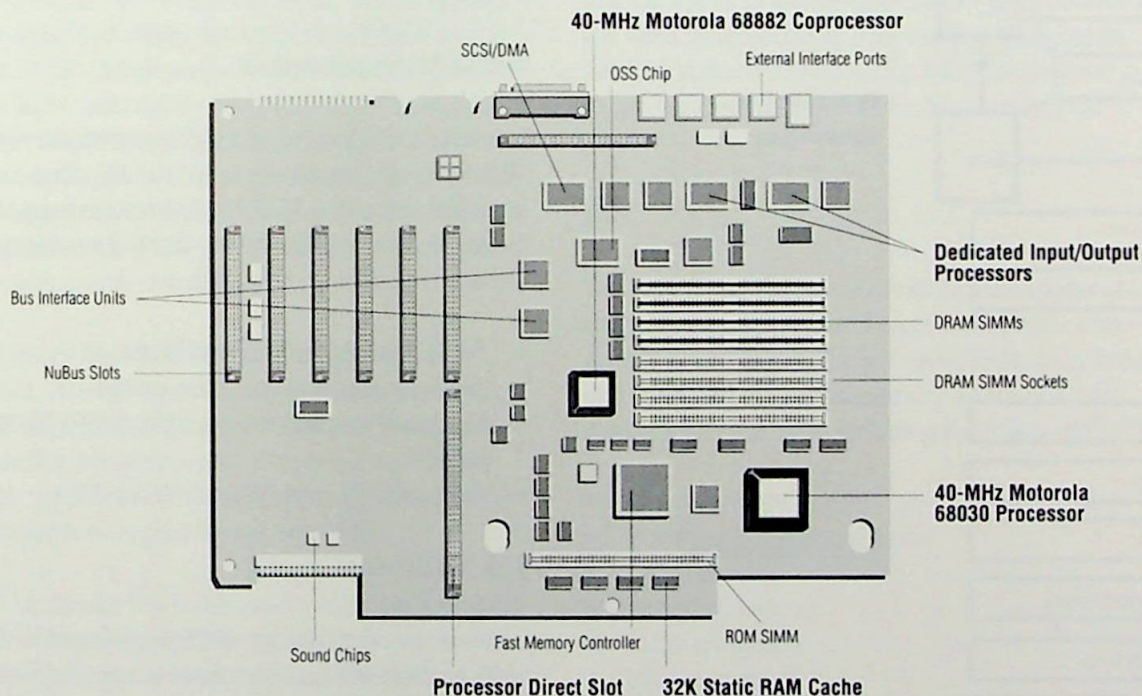
peripherals such as hard disks and printers, LocalTalk® network connections, and Apple Desktop Bus devices.

For floppy disk storage, the Macintosh IIfx uses the 1.4-megabyte Apple SuperDrive™ disk drive, and it can be configured with up to 160 megabytes of internal hard disk storage; it will also accommodate a second SuperDrive.

Product Design

The Macintosh IIfx logic board is Apple's most highly integrated design; it melds many new technologies effectively, providing compatibility for thousands of existing Macintosh applications. The logic board components are illustrated below.

Macintosh IIfx Logic Board

- SCSI/DMA
- 40-MHz Motorola 68882 Coprocessor
- OSS Chip
- External Interface Ports
- Dedicated Input/Output Processors
- DRAM SIMMs
- DRAM SIMM Sockets
- 40-MHz Motorola 68030 Processor
- Bus Interface Units
- NuBus Slots
- Sound Chips
- Fast Memory Controller
- ROM SIMM
- Processor Direct Slot
- 32K Static RAM Cache

The Macintosh IIfx architecture is divided into two parts: the Processor subsystem and the I/O subsystem. The Processor subsystem is a tightly coupled area that contains the main system processor and the memory subsection. The I/O subsystem consists of all of the input/output components. (See illustration below.) A set of buffers separate the processor subsystem and the I/O subsystem, allowing a large number of slower devices on the I/O subsystem without degrading performance or upsetting timing margins in the critical CPU/Memory subsection.
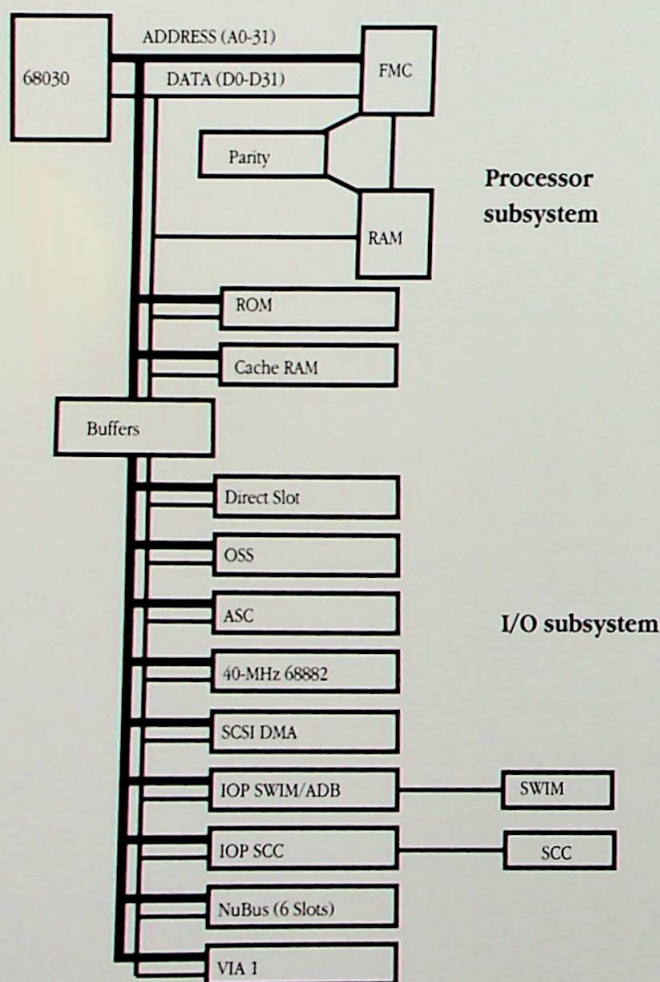
Processor Subsystem

The Processor subsystem separates the processor from memory subsystems of the Macintosh IIfx, permitting all cache and memory access to take place at 40 megahertz (MHz). The Processor subsystem consists of the following:

- 68030 microprocessor
- 32K Static RAM Cache
- DRAM
- Parity support
- FMC (Fast Memory Controller)
- ROM

68030 Microprocessor

In addition to operating at a higher speed, the 40-MHz version of the Motorola 68030 CPU offers the same features as the 15.6672-MHz version found in the SE/30, IIcx, and IIx and the 25-MHz version in the IIci. Those features include:

- Full 32-bit address and data buses
- 256-byte data and instruction caches
- Hardware memory management (68851 PMMU subset)
- Compatibility with previous 680x0 CPUs

32K Static RAM Cache

Standard on every Macintosh IIfx logic board is 32K of 25-nanosecond (ns) static RAM (compared with the 80ns speed of main memory). Because the CPU can access the 32K Static RAM Cache in two clock cycles (zero wait states), applications can run very quickly. When the CPU asks for information not contained in the cache, a miss occurs; the requested information is loaded from dynamic RAM (DRAM), which takes six clock cycles, or from ROM, which takes eight clock cycles.

Processor subsystem diagram showing 68030, ADDRESS (A0-31), DATA (D0-D31), FMC, Parity, RAM, ROM, Cache RAM, Buffers, and I/O subsystem components: Direct Slot, OSS, ASC, 40-MHz 68882, SCSI DMA, IOP SWIM/ADB (connected to SWIM), IOP SCC (connected to SCC), NuBus (6 Slots), VIA 1.

The 32K Static RAM Cache augments the 256-byte cache inside the 68030. When the 68030 looks for data, it first checks its own internal 256-byte cache. If the data is not found in the 68030 cache, the 32K of cache on the Macintosh IIfx logic board is searched. Data is found in the 32K Static RAM Cache more than 90 percent of the time. If the data is not in the 32K cache, it is loaded from the main memory or from ROM.

DRAM

The Macintosh IIfx features 4 megabytes (MB) of main memory, or DRAM, which can currently be expanded to 8MB and in the future will be expandable to up to 128MB. Macintosh IIfx DRAM uses a new 64-pin SIMM connector that separates the RAM data input and output. The Macintosh IIfx can thus write DRAM and read ROM or the cache at the same time, significantly increasing overall CPU/32K Static RAM Cache/DRAM performance. Other Macintosh SIMMs, including those in the IIci, are not compatible with the Macintosh IIfx.

Macintosh IIfx DRAM is 80ns, fast-page-mode DRAM. The Macintosh IIfx does not support 1MB, 2MB, or 5MB configurations because the memory controller recognizes only 1MB or greater-density RAM. A Macintosh IIfx 4MB Memory Expansion Kit is available to expand memory to 8MB.

The Macintosh IIfx is designed to support 4-megabit and 16-megabit chips when they become available, enabling the system to support up to 128MB of main memory. However, the current version of the Macintosh System Software, Version 6.0.5, can support no more than 8MB of main memory. Like the IIci, the Macintosh IIfx supports burst reads to memory. In the Macintosh IIfx, burst-mode reads

are also supported for ROM access. The IIfx supports zero-wait-state writes to memory by using 64-pin SIMM strips and a new memory controller technique called "latched writes." Because it allows the memory controller to capture data immediately, the latched-write technique frees the processor to perform other tasks from cache or from ROM (but not from RAM).

Parity Support

Like the Macintosh IIci, the Macintosh IIfx has a parity option that consists of parity SIMMs and an additional chip on the logic board. In the Macintosh IIfx, the speed of the memory on the parity SIMM has been increased from 80ns to 60ns, allowing the memory controller to speed up DRAM access and regain the extra clock cycle necessary to support parity.

FMC

The FMC (Fast Memory Controller) is an Apple custom integrated circuit designed to operate with the 68030 and to support fast cache RAM, main RAM, and ROM. All processor/memory operations are controlled by the FMC, including the following:

- 32K Static RAM Cache
- Burst-mode reads and writes
- Latched writes
- DRAM addressing
- ROM addressing
- Processor speed

ROM

The Macintosh IIfx ROM is based on the Macintosh IIci ROM. Modifications include the following:

- IOP Manager (new)
- Start Manager (modified; hardware specific)
- Shut Down Manager (modified; hardware specific)
- Bug fixes in the Macintosh IIci ROM

I/O Subsystem

The I/O subsystem contains the input/output subsection of the Macintosh IIfx. When the CPU accesses any device (except the 68882 coprocessor) on the I/O subsystem, clock speed drops to 20 MHz; that is, the I/O subsystem runs at half the clock speed of the processor. If the Macintosh IIfx didn't slow the processor down, it would have to insert a large number of wait states for the slower I/O chips to respond. The I/O subsystem consists of the following:

- PDS (Processor Direct Slot)
- 40-MHz 68882 coprocessor
- ASICs (application-specific integrated circuits)
- IOPs
- SCSI/DMA controller
- OSS (Operating System Services) chip
- NuBus

Macintosh IIfx PDS Slot

The Macintosh IIfx features a Processor Direct Slot (PDS) that is similar to (but not interchangeable with) the Macintosh SE/30 PDS; both use the 120-pin Euro-DIN connector. The PDS provides access to the Macintosh IIfx CPU bus. The benefit of using the PDS connector over NuBus is increased performance: NuBus runs at 10 MHz, while most cards designed for the Macintosh IIfx PDS will take

advantage of a more direct, 20-MHz path to the Processor subsystem.

When a PDS card is installed in the Macintosh IIfx system, you can have only five NuBus cards in the machine, for two reasons: First, the connector is located in line with NuBus Slot E to allow easy cable routing to the outside world; and second, if you fill all the NuBus slots and use a PDS card, you'll overload the power supply.

Note that you cannot use the Macintosh IIci Cache Card in the PDS slot; doing so causes severe damage to both the logic board and the cache card.

68882 Coprocessor

The Macintosh IIfx features a 68882 coprocessor, running at 40 MHz, on the I/O subsystem of the bus. Because floating-point operations are a critical aspect of performance, all transfers involving the processor take place at 40 MHz. The Motorola 68882 has the following features:

- High-speed floating-point computations
- IEEE floating-point accuracy
- Parallel operation with the 68030
- Compatibility with the 68881 coprocessor

The asynchronous interface allows commands to be sent to the 68882, and lets the processor return to other operations while calculations are being performed.

ASICs

Hardware integration is achieved with custom logic ASICs (application-specific integrated circuits), which combine many discrete, off-the-shelf compo-

nents to create a single new chip. For example, it is possible to use an ASIC to combine an NCR SCSI 53c80 controller and a DMA circuit into one chip. Using ASICs has the following advantages:
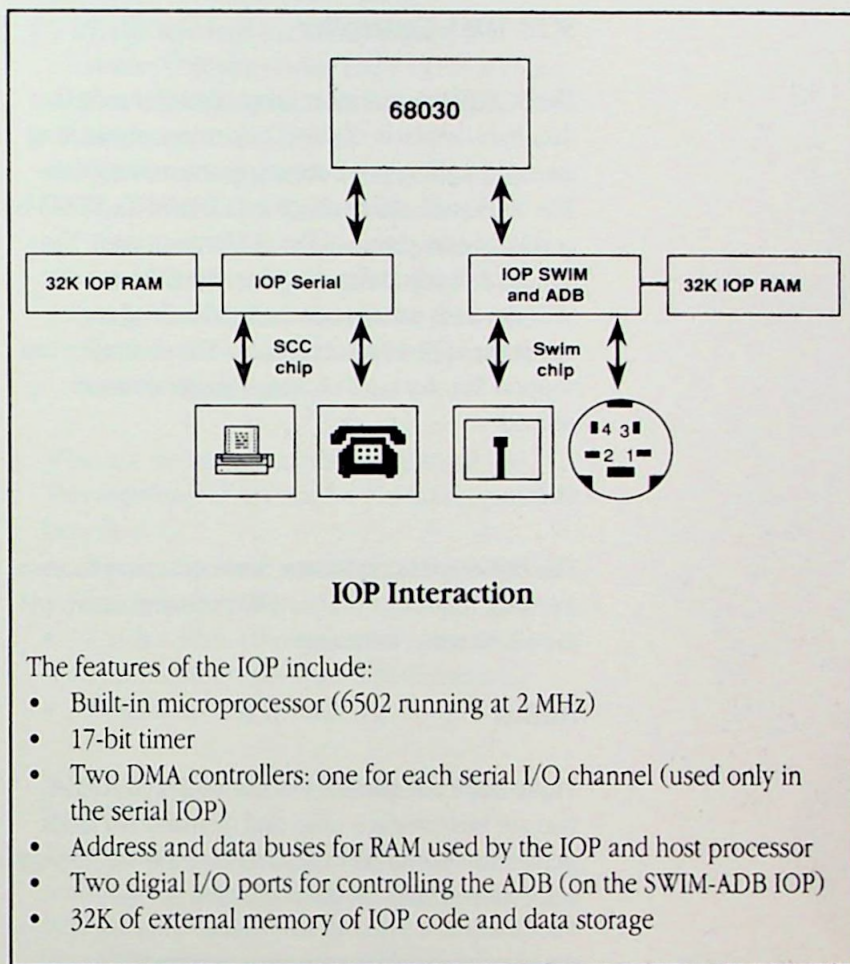
- ASICs free up logic board space, allowing board designers to place components closer together and increase functionality in the same space.

- ASICs increase reliability because one ASIC replaces many other components, decreasing the chances of failure.

- ASICs enhance performance. Integrating many chips into one ASIC decreases timing delays caused by chip-to-chip communication.

- ASICs reduce costs. Discrete logic (both the parts and the printed circuit board) costs more and uses more power to accomplish the same task.

IOPs

The Macintosh IIfx features two I/O processors (IOPs) designed to provide intelligent support for the I/O chips. One IOP is for the SWIM and Apple Desktop Bus (ADB), and one is for the Serial Controller Chip (SCC). Each contains a 6502-family microprocessor and 32K of RAM to perform I/O tasks. (See illustration at right.)

- SWIM/ADB

  This IOP relieves the 68030 of floppy disk drive and ADB tasks. In earlier systems, when the SWIM chip was accessed, interrupts on the 68030 were disabled to provide proper timing. Since the IOP handles SWIM interaction, the interrupt lines of the 68030 are not disabled

IOP Interaction

The features of the IOP include:
- Built-in microprocessor (6502 running at 2 MHz)
- 17-bit timer
- Two DMA controllers: one for each serial I/O channel (used only in the serial IOP)
- Address and data buses for RAM used by the IOP and host processor
- Two digial I/O ports for controlling the ADB (on the SWIM-ADB IOP)
- 32K of external memory of IOP code and data storage

during disk access. It also handles the generation of the ADB packets and transmission, resulting in better I/O under the A/UX® operating system and little difference under the Macintosh operating system.

- SCC

The SCC IOP handles interaction with both serial ports. It provides support for LocalTalk to relieve the CPU from the interrupts created by LocalTalk transmissions.

SCSI/DMA Controller

The SCSI/DMA controller takes control during the data transfer phase of the SCSI session, eliminating the need for 68030 processing when moving data. The 68030 will still handle the COMMAND, STATUS, and MESSAGE phase of the SCSI transaction. The timing of data transfers between the CPU and the SCSI device is maintained by handshaking logic inside the SCSI/DMA controller. The controller can support transfer rates of up to 3 megabytes per second.

OSS

The OSS (Operating System Services) chip processes interrupt requests from the I/O chips and interrupts the 68030 when necessary.

NuBus

Three chips connect the Macintosh IIfx to NuBus: two are bus interface units and the third is a clock generator. These new chips replace the NuChip and associated buffers on the Macintosh II.

System Software

The Macintosh IIfx supports both operating systems available for the Macintosh line: System Software Version 6.0.5 and A/UX Version 2.0 (earlier versions of A/UX are not compatible). See page 13 for more information on System Software 6.0.5.

Product Configurations/Upgrades

The Macintosh IIfx comes in the following configurations:

- M5510LL/A   4MB RAM; SuperDrive
- M5515LL/A   4MB RAM; 80MB hard disk
- M5520LL/A   4MB RAM; 160MB hard disk
- M5523LL/A   4MB RAM; 80MB hard disk containing A/UX
- M5524LL/A   4MB parity RAM; 80MB hard disk

These upgrades are available:

- M0376LL/A   4MB Macintosh IIfx RAM Expansion Kit
- M0377LL/A   4MB Macintosh IIfx Parity RAM Expansion Kit

Macintosh IIfx Upgrade

The Macintosh IIfx Logic Board Upgrade (M0375LL/A) gives users of Macintosh II and IIx computers all the advantages of the Macintosh IIfx. The upgrade includes the following:

- Macintosh IIfx Logic Board*
- Macintosh IIfx Accessory Kit, including System Software 6.0.5 and documentation
- HyperCard® 1.2.5 and documentation

* No DRAM is included on the logic board; it must be purchased separately. This reduces the cost of the upgrade, allows you to choose either Apple or third-party memory, and provides greater flexibility when configuring a system.

✍

Macintosh IIfx Q&A

Q: Do all Macintosh applications run on the IIfx?

A: Virtually all Macintosh applications run on the Macintosh IIfx, as do virtually all NuBus cards.

Q: Which applications will take advantage of the power of the Macintosh IIfx?

A: All Macintosh applications will take advantage of its power. Mainstream applications such as word processors and spreadsheets will be faster and more responsive, as will computing-intensive tasks such as scientific and engineering activities.

Q: How many new application-specific integrated circuits (ASICs) are on the Macintosh IIfx logic board?

A: There are a total of seven new ASICs. Two are Peripheral Interface Control (PIC) chips (I/O processors), which are dedicated to controlling low-level routines such as serial communications and floppy disk access. A Small Computer System Interface/Direct Memory Access (SCSI/DMA) chip controls the SCSI bus. The Operating System Support chip, a multipurpose ASIC, is dedicated to managing interrupts from external sources so they are synchronized with the internal bus. A Bus Interface Unit 30 chip and a Bus Interface Unit 2 chip drive NuBus processes and bus synchronization, respectively. A Fast Memory Controller (FMC) chip controls access from the cache, ROM, and RAM to the system's main processor. Four additional ASICs were also included in the Macintosh IIci design.

Q: With all this integration on the Macintosh IIfx, why didn't you put it in a three-slot design?

A: There are three key reasons:
- Many of our customers are OEMs and VARs, who take Macintosh technology and add significant value with special solutions. These solutions frequently require the system's six-slot design and Processor Direct Slot, either for maximum expandability or for maximum NuBus power.
- We wanted to provide an upgrade path for Macintosh II and Macintosh IIx owners.
- To achieve the fully balanced system design, we needed to integrate the built-in 32-bit cache, the Processor Direct Slot, and other features that wouldn't have been possible in a three-slot design.

Q: What are the benefits of this integration?

A: This high level of integration yields four major benefits:
- It opens up more space on the board for future functionality.
- It yields more efficient use of power.
- It increases overall system performance.
- It increases system reliability.

Q: What advantages does the Macintosh IIfx gain from the chips?

A: The PIC chips are important to the overall performance of the Macintosh IIfx system, because they balance the increase in clock speed (to 40 MHz) by ensuring that I/O processes keep pace with the processor's speed. In addition, they free the main processor from processing low-level interrupts. As a result, the PIC chips provide high levels of dedicated and predictable performance for standard I/O routines. For example, network routing techniques on the Macintosh IIfx are completely transparent to users working with any number of Macintosh applications. In future versions of the Macintosh operating system, the Macintosh IIfx will take greater advantage of the PIC chips' capabilities.

Q: Are you going to be shipping the Macintosh IIfx system with NuBus cards installed?

A: The cover of the IIfx has a special, improved design that allows Apple factories to preconfigure the systems with NuBus cards installed, in response to customer demands. As manufacturing processes evolve to utilize this hardware capability, we will start shipping systems with NuBus cards preinstalled.

Q: Are you shipping the Macintosh IIfx with system software preinstalled, as you did with the Portable?

A: System Software Version 6.0.5 and HyperCard Version 1.2.5 are preinstalled on Macintosh IIfx systems that have 80MB and 160MB internal hard disks, further enhancing ease of setup.

Q: Will the Macintosh IIfx run System Software Version 7.0

A: The Macintosh IIfx supports the virtual memory and 32-bit addressing capabilities of Version 7.0, and will be able to run the software when it becomes available.

Q: Why did you choose to use new DRAM for the Macintosh IIfx?

A: Optimizing the system's capability to run at 40-MHz requires balancing the system's entire architecture, including DRAM access. We chose the new 64-pin DRAM for the Macintosh IIfx because it provides a higher level of DRAM-access performance, by allowing the system to perform overlapped writes to DRAM concurrent with reads from the cache or ROM.

Q: Does this mean that Macintosh II and IIx customers who wish to upgrade to the Macintosh IIfx have to buy new DRAM, also?

A: Yes. The Macintosh IIfx–specific DRAM (which is faster and features a new SIMM module) is available from Apple and third parties.

Q: Are the I/O processors and the SCSI/DMA controller fully utilized by both A/UX and the Macintosh operating system?

A: A/UX takes full advantage of the I/O processors and the SCSI/DMA chip. The Macintosh operating system also recognizes significant benefits from the I/O processors and the SCSI/DMA, performing these devices relieve the 68030 CPU from low-level interrupts and routines for serial communications, Apple Desktop Bus processes, floppy disk drive control, and SCSI routines. Consequently, Macintosh IIfx users will experience smoother mouse movement and improved performance when using the system as a network router (managing the interaction between two separate networks), among other benefits. As the Macintosh operating system evolves, it will take even greater advantage of these hardware enhancements, just as A/UX does today.

Q: Are you creating a new bus with the PDS?

A: The PDS, by definition, is linked to the processor. So when a vendor changes a processor's clock speed, of course, the PDS architecture must be changed as well. The Macintosh IIfx PDS is a superset of the Macintosh SE/30 PDS. As a result, it will be relatively easy for third parties to revamp a Macintosh SE/30 card to work on the Macintosh IIfx. We should point out that processor direct slots tend to be created for very task-specific applications and for a specific hardware platform.

10

Q: What's the internal storage strategy for the Macintosh IIfx?

A: We offer the IIfx in three standard internal storage configurations: a floppy-only version with a SuperDrive disk drive; a IIfx with a SuperDrive and an 80MB internal hard disk; and one with a SuperDrive and a 160MB internal hard disk. This provides customers and resellers with a range of options. We believe the most popular IIfx configurations will be the 80MB and 160MB versions, but by creating a floppy-only configuration, we give customers and resellers the option to configure a system with more internal storage, if they want it.

Q: Are there plans for a three-slot version of the Macintosh IIfx?

A: We expect the Macintosh IIfx to appeal to customers who have high-performance comput-ing needs. And usually these customers want maximum expandability, too. So a six-slot system makes sense for them. The Macintosh IIci is a three-slot, 25-MHz 68030 system that has been very popular with people who want high performance in a small-footprint design.

Q: Can users upgrade from Macintosh II to the Macintosh IIfx?

A: A logic board upgrade is available for both Macintosh II and Macintosh IIx customers. All that's necessary is a logic board swap, as the form factor of the Macintosh IIfx is the same as that of the Macintosh II and IIx.

Q: Why is there no onboard video for the Macintosh IIfx?

A: Onboard video makes sense for a more mainstream product like the Macintosh IIci. But we believe our Macintosh IIfx customers will opt for as much power and flexibility as possible.

One of the six NuBus slots can be used for the customer's video card of choice, including 24-bit color cards from Apple and third-party vendors. The Macintosh IIfx also runs the new family of Macintosh Display Cards, including the 8•24 GC card.

Q: Why is there no Ethernet Interface on the logic board of the Macintosh IIfx?

A: Ethernet is an important direction for the future. But until we can fit the right Ethernet control logic on the logic board while offering the same level of plug-and-play functionality provided by LocalTalk, we will continue to support LocalTalk as our built-in networking interface of choice. Currently, NuBus provides a powerful and flexible connectivity solution. In addition AppleTalk® networking capability is built into every Macintosh system, including the Macintosh IIfx.

Q: Is the Macintosh IIfx a workstation?

A: At Apple Computer, we are in the personal computing business. That means we make broad-based tools that help people perform a wide range of mainstream and general-purpose tasks, from word processing to database management, and from desktop publishing to personal productivity. Clearly, as we add more power and functionality to our Macintosh architecture, Macintosh computers will include many of the features found in workstations. And consequently, Macintosh users will increasingly be able to perform many of the tasks that many workstation users perform today—especially in the scientific and engineering markets. And they'll be able to perform these tasks in the distinctive Macintosh fashion.

Q: When will Apple include a Motorola 68040 chip in a Macintosh computer.

A: We have had a long and successful relationship with Motorola and we plan to incorporate its new technology into our systems when it is appropriate for us to do so and when those components are available in enough volume to meet expected customer demand.

✍️

Macintosh System Software Version 6.0.5

The Macintosh System Software Version 6.0.5, the latest version of the operating system for the Macintosh family of computers, incorporates hardware support for the Macintosh IIfx, the Macintosh Display Card 8•24, and the Macintosh Display Card 8•24 GC. It also contains minor bug fixes appropriate for some users. System Software Version 6.0.5 coexists in networked environments with System Software Versions 6.0.2, 6.0.3, and 6.0.4.

Apple also recommends using System Software Version 6.0.5 with the following products:

- Macintosh Portable

- Macintosh IIci

- 32-Bit QuickDraw™

System Software 6.0.5 corrects two problems associated with the Macintosh Portable:

- A communications problem experienced when the Portable is connected to serial devices. The symptom is that the Portable loses track of printers and modems after coming out of Sleep mode.

- A power-consumption problem encountered when the Portable is shut down while connected to the AppleTalk network. The symptom of this problem is that the battery discharges quickly.

The new system software also addresses the following compatibility issues associated with the Macintosh IIci:

- Control-break characters received through the serial port no longer cause a system crash.

- 32-Bit QuickDraw Version 1.2 offers additional dithering capabilities, support for variable-resolution PICT images, and font information stored in PICT images.

- Zero-width characters (used for music programs and accented characters) now work properly.

Installation Procedure

To ensure the proper installation of Version 6.0.5, you must remove any virus-detection or security programs from the System Folder. You can re-install them after you install Version 6.0.5.

Distribution

System Software Version 6.0.5 is packaged with all new Macintosh personal computers. It is also available from all authorized Apple resellers and through the AppleLink® network and other on-line services.

Update Policy

The software and manuals for Macintosh System Software Version 6.0.5 are available for a suggested U.S. retail price of $49.95.

✍️

Overview: Macintosh Display Cards

The Apple Macintosh Display Cards 4•8, 8•24, and 8•24 GC greatly extend the performance and flexibility of the Macintosh video card product line, and consolidate the capabilities, as illustrated in the graphic on page 15. The Display Card 4•8 and the Display Card 8•24 provide the Macintosh II family with a single interface to all Apple displays and to a broad range of graphics capabilities. The Display Card 8•24 GC augments the features of the Display Card 8•24 with the power of a dedicated graphics coprocessor, providing sophisticated graphics capabilities at significantly faster drawing speeds.

The Macintosh Display Cards 8•24 and 8•24 GC support all Apple displays to the maximum of their capabilities, including full 256-level "true gray scale" on all Apple displays. The cards also support full 24-bit "true color" capability on the AppleColor High-Resolution RGB Monitor, allowing users to display any of 16.7 million colors simultaneously. The combination of true gray scale and true color capabilities lets you display and work with photographic-quality images as well as with lifelike simulations, animations, and visual effects.

The Macintosh Display Card 8•24 GC contains a RISC-based Am29000 microprocessor that runs a version of QuickDraw optimized for a coprocessing environment. The Am29000 and the Macintosh CPU work together to accelerate the QuickDraw environment—from 5 to 30 times depending on the application. As a result, graphics-intensive applications work faster and more smoothly, especially when using full 24-bit color.

All three cards support RS-170 standard timing for compatibility with numerous interlaced video devices. The Macintosh Display Cards 8•24 and 8•24 GC provide the highest-possible-quality interlaced video through the use of Apple Convolution.
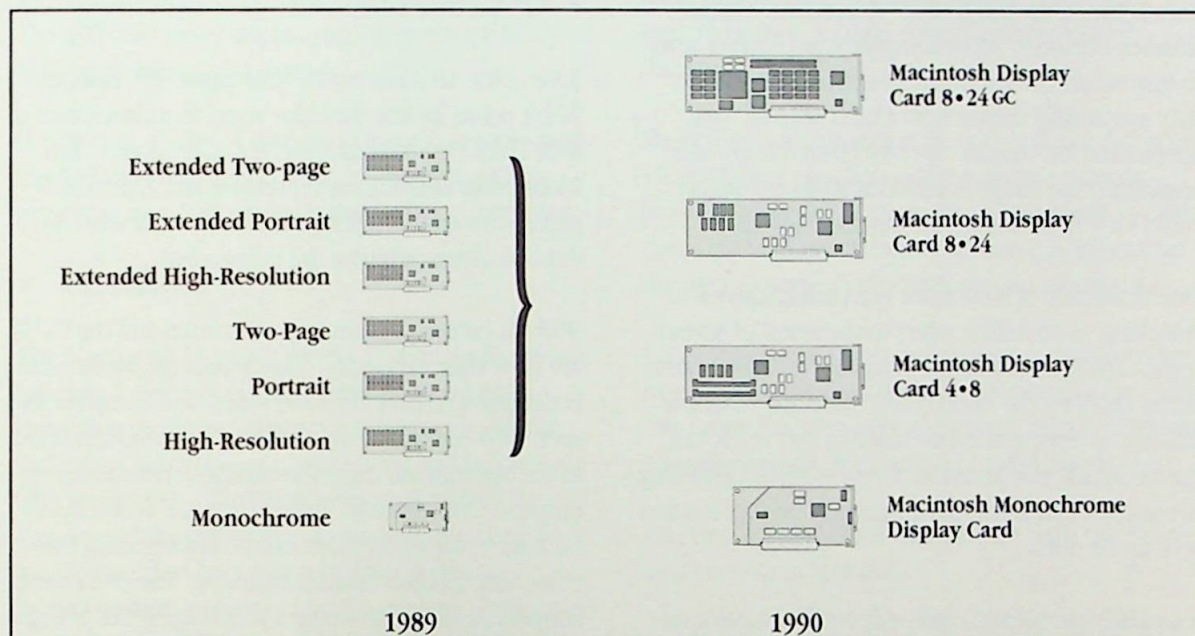
Macintosh Display Cards 4•8 and 8•24

The Macintosh Display Card 4•8 provides support for up to 256 colors or shades of gray on the Apple High-Resolution Monochrome Monitor and the AppleColor™ High-Resolution RGB Monitor. It provides up to 16 shades of gray on the Apple Macintosh Portrait Display and the Apple Two-Page Monochrome Monitor.

The Macintosh Display Cards 4•8 and 8•24 offer 24-bit color at an affordable price. The following paragraphs discuss the advantages of 24-bit color and other features.

Apple's New Display Card Family

Extended Two-page

Extended Portrait

Extended High-Resolution

Two-Page

Portrait

High-Resolution

Monochrome

Macintosh Display Card 8•24 GC

Macintosh Display Card 8•24

Macintosh Display Card 4•8

Macintosh Monochrome Display Card

1989

1990

• **CLUT and 8-bit color images**

With the earlier 8-bit Macintosh II Video Card, each pixel is represented by an 8-bit color value. The 24-bit value represents the color nearest to the one indicated by the 8-bit pixel value. The 24-bit color value consists of 8-bit values for red, green, and blue; each is sent through one of the three 8-bit digital-to-analog converters (DACs) for conversion to analog color signals.

32-bit QuickDraw derives an 8-bit image by taking each 24-bit pixel value from the original 24-bit image and, using the Color Manager, finding the closest approximation of that color in the Color Lookup Table (CLUT). The 8-bit index of the closest approximate color is placed in the frame buffer and represents that pixel's value.

Graphic imaging with 8-bit color video is reasonably accurate if the CLUT is set up with colors that are appropriate for the color mix of the image being

Lookup Value 0	Red 8-bit Value	
	Green 8-bit Value	
	Blue 8-bit Value	
Lookup Value 1	Red 8-bit Value	
	Green 8-bit Value	
	Blue 8-bit Value	
Lookup Value 2	Red 8-bit Value	
	Green 8-bit Value	
	Blue 8-bit Value	
. . .	Red 8-bit Value	
	Green 8-bit Value	
	Blue 8-bit Value	
Lookup Value n	Red 8-bit Value	
	Green 8-bit Value	
	Blue 8-bit Value	

Pixel Map Value → ... → To Digital/Analog Converters

Color Lookup Table (CLUT)

drawn, and if the image does not require a large number of colors. Very complex color images tend to lose much of their detail and shading because they are usually drawn with a high ratio of "best approximation" colors. A color printed copy of a complex color image scanned at 8 bits per pixel could look quite different from the original.

One drawback of 8-bit color is an effect known as "blocking," a term that refers to the result of several slight variations of a single color being represented in the CLUT by the same color. Blocking makes it difficult to represent subtle shading and leads to a loss of detail. For instance, a very gradual lightening of the color red across an image may be represented by a single red.

A similarly problematic side effect of 8-bit color is known as "banding." Banding can be seen in an 8-bit representation of an image made of only a few different colors, but an almost infinite number of shades of those colors. A 256-color CLUT doesn't have enough colors to handle such an image, and subtlety is lost. Areas where one color gradually blends into another eventually look like bands of one color blending into bands of the other, with each band of color being the CLUT's closest approximation of several marginally different colors.

"Dithering" is an effect that may allow a closer approximation to the original image. Dithered colors rely on grouping a number of pixels in a certain pattern to give the effect of a color not found in the CLUT. Since pixels are so small and so close together, a grouping of blue and yellow pixels produces an effect similar to green pixels. While dithering can improve the rendering of a complex image, the result is still an approximation.

- **24-bit true color**

True color, also known as "photographic" color or 24-bit color, avoids the color approximation issues of 8-bit color by allowing 8 bits for each color. Thus 24-bit color delivers an impressive 16,777,216 red-green-blue combinations—far more color shades than are discernable by the human eye.

With 24-bit color, color approximation and the CLUT are no longer necessary. That's because 24-bit color is directly interpreted by the video card firmware as each 8-bit red, green, and blue color definition is fed to the appropriate digital-to-analog converter for output to the monitor. Images that are problematic for 8-bit color video cards can be drawn using true color with all their brilliant nuances. The 8•24 cards support 24-bit color on the 13-inch AppleColor High-Resolution RGB Monitor.

- **True grays**

The Macintosh Display Card 4•8 supports 256 shades of gray, or "true grays," on all Apple monitors except the portrait and two-page displays, on which 16 grays are supported. The Display Card 8•24 adds support for true grays on the portrait and two-page displays. When driving the two larger monochrome displays, the 8•24 card uses only the green signal in all its 256 saturation levels to accomplish the full spectrum of grays.

- **Monitor support**

A programmable pixel clock chip and a 100-MHz oscillator on the new display cards enable them to support all current Macintosh monitors. The pixel depth supportable on each monitor is a function of the amount of video RAM (VRAM) installed on the display card. The Display Card 4•8 has 512K of

VRAM and the Display Card 8•24 has 1 megabyte. The 100-MHz oscillator provides support for the Macintosh two-page monitor.

In addition, the 8•24 card supports 256 colors—and the 4•8 card supports 16 colors—on portrait and two-page monitors made by third-party companies.

●   **Convolution**

The Macintosh Display Card 8•24 reduces flicker on interlaced video devices by running every pixel through a formula that averages the pixel with the individual neighboring pixels above and below. This technique, called *convolution*, is part of the function of the color chip. Convolution causes an averaging effect between scan lines so that a horizontal line includes at least a portion of the scan lines above and below its own scan line. To reduce flicker, a portion of a single-pixel-height horizontal line remains visible during display of both the odd and the even fields. The convolution formula follows a 1:2:1 ratio, where the current pixel value is given twice the weight of its neighbors above and below.

The Macintosh Display Card 4•8 does not support convolution because of memory requirements; the 8•24 supports convolution (at up to 8 bits per pixel; the filtering process requires two logically interleaved banks of memory), automatically turning it on where appropriate. If a Display Card 8•24 is driving an interlaced display in 24-bit mode convolution is disabled. If the card is driving an interlaced display in 8-bit mode, or a lesser pixel depth, convolution is enabled.

●   **Underscan and overscan**

The full 640 x 480 active video display is visible on an interlaced monitor if the monitor operates in *underscan* mode. (Underscan means that the monitor screen is larger than the active video display.)

Many interlaced monitors do not show the full active video display area because the picture extends beyond the edges of the screen. This mode is called *overscan* because the scanned image is larger than the display area. (Television sets use overscan.)

To guarantee that the whole image is visible on an overscan monitor, all three of the new display cards can be switched to overscan mode, which produces a smaller display with only 512 x 384 pixels.

The new display cards can support both overscan and underscan monitors.

●   **Memory organization**

The frame buffer controller is a custom gate array that serves as the controller for the 4•8 and 8•24 display cards. It implements an address translation scheme that allows the cards to use only 1MB of VRAM to support 24-bit graphics, even though a 640 x 480 monitor displaying 24-bit graphics would normally require 1.5MB of VRAM. The 8 bits of data in each pixel that do not convey any color (or gray-scale) information are ignored. Such compaction allows 24-bit data for a 640 x 480 monitor to fit in just over 900K of VRAM. The 8 bits that are ignored are defined as the alpha channel and, when maintained, can be used for special effects.

Macintosh Display Card 8•24 GC

The Macintosh Display Card 8•24 GC implements the entire feature set of the Display Card 8•24, with the addition of accelerated drawing of images.

Unaccelerated 24-bit imaging can be slow, but the Macintosh Display Card 8•24 GC uses several methods to provide a thorough and integrated solution. It accelerates the drawing of images by 5 to 30 times, with greatest acceleration realized when drawing very complex images. (Users of applications that circumvent QuickDraw may see little or no acceleration.)

The 8•24 GC supports convolution for interlaced displays at up to 8 bits per pixel. The card's resident video RAM is not compressed the way VRAM is on the 4•8 and 8•24 cards, which means that the extra alpha channel byte is maintained.

• Accelerating graphics

One effective method for accelerating graphic imaging is the use of a coprocessor dedicated to drawing images. This frees the 680x0 to continue program execution without having to wait for the time-consuming imaging of 8- to 24-bit pixel images. The Macintosh Display Card 8•24 GC uses the RISC-based Am29000 microprocessor to relieve the 680x0 of the imaging process. The Am29000 was chosen instead of a graphics processor because specialized graphics processors would be inadequate for the Display Card 8•24 GC; they are unable to handle complex QuickDraw operations and setup code.

• Interprocess communication

The Macintosh Display Card 8•24 GC uses an interprocess communication (IPC) specific to the two processors—it is not application accessible. Streamlined for low overhead and fast response time, the IPC resident on the Display Card 8•24 GC intercepts QuickDraw calls on the Macintosh and passes them and their parameters to the special

version of 32-bit QuickDraw that resides on the card. The IPC also makes it possible for the customized version of QuickDraw to call specific routines running on the Macintosh.

• NuBus data transfer

Transferring large and deep bitmaps across the NuBus is the slowest part of the drawing process. Typical reads and writes from the Macintosh to the display card are performed in 1,000 and 500 nanoseconds, respectively. NuBus data transfer time is affected by the need to rearbitrate for control of the bus after each 32-bit word is transferred.

The Macintosh Display Card 8•24 GC optimizes NuBus data transfer for faster average access times and drawing speeds; it reads only QuickDraw variables and small portions of data structures across NuBus. The bitmaps are then created locally in the VRAM of the Display Card 8•24 GC. The card reads and writes to its frame buffer memory at a rate of 66 to 132 nanoseconds, and up to 2MB of DRAM on the card holds offscreen bitmaps.

• 32-bit QuickDraw optimized for the Am29000

The 32-bit QuickDraw on the Display Card 8•24 GC produces the same graphic output as standard 32-bit QuickDraw. However, several algorithms have been modified, and internal organization has been altered to fit into the graphics accelerator architecture.

The Macintosh Display Card 8•24 GC provides transparent acceleration of any Macintosh application. No extra work need be done by an application to take advantage of the card's optimized 32-bit QuickDraw.

- **NuBus block transfer**

One important display card acceleration feature is the NuBus block transfer function. The NuBus controller on the Macintosh Display Card 8•24 GC supports both master and slave NuBus block transfer. The Macintosh Display Cards 4•8 and 8•24 support NuBus block transfers in slave mode only.

Because most Macintosh systems do not support NuBus block transfer, this function is primarily a factor between NuBus cards with block transfer abilities. However, the Macintosh IIfx does support block transfers in slave mode only.

NuBus block transfer facilitates faster movement of data. Normally data is moved across NuBus in 32-bit words, 16-bit half-words, or bytes. Bus availability must be arbitrated after each word is transferred. Under NuBus block transfer, the bus is arbitrated by the master, and then held while one address word and 16 data words are transferred to the addressed NuBus slave. Block transfer mode significantly accelerates the flow of data from card to card.

Because the Macintosh and many other NuBus cards lack NuBus block transfer support, another scheme is used to speed up data transfer between the Display Card GC 8•24 GC and other NuBus clients. Pseudo-block transfer is similar to block transfer in that it claims the bus for a transaction of 16 NuBus data words; however, it must send an address word for each data word that it sends. The extra transfer activity makes pseudo-block transfer slower than block transfer, but still an improvement over normal NuBus access times.

- **Multiple Display Cards in One System**

When multiple display cards are installed, the Macintosh Display Card 8•24 GC accelerates drawing in frame buffers of the Macintosh Display Cards 4•8 or 8•24, or other frame buffer cards. The Display Cards 4•8 and 8•24 show the most improvement because they support slave NuBus block transfers, whereas many other display cards do not. Acceleration for frame buffers other than the one resident on the Display Card 8•24 GC would not be as dramatic because of the greater amount of NuBus traffic required. Only one 8•24 GC card may be used for graphics acceleration in a system; if you use two 8•24 GC cards, one of them will automatically turn off its acceleration function.

Upgrades

The Macintosh Display Card 4•8 can be upgraded to the Display Card 8•24 with the Macintosh Display Card VRAM Kit.

The Macintosh Display Card 8•24 GC can be upgraded with the Macintosh Display Card DRAM Kit, which improves the performance of applications that use large off-screen bitmaps and other imaging methods.

System Software

The Macintosh System Software Version 6.0.5 or greater is required with the Display Cards 4•8, 8•24, and 8•24 GC. Macintosh II, IIx, and IIcx systems require the 32-bit QuickDraw addition to the system software (available on AppleLink® or from your authorized Apple reseller). Macintosh IIci and IIfx systems have 32-bit QuickDraw in ROM and require only System Software Version 6.0.5 or greater.

Display Modes Supported

Display	Macintosh Display Card 4•8	Macintosh Display Card 8•24 or 8•24 GC
Apple High-Resolution Monochrome Monitor	640 x 480 pixels 2, 4, 16, or 256 grays	640 x 480 pixels 2, 4, 16, or 256 grays
AppleColor High-Resolution RGB Monitor	640 x 480 pixels 2, 4, 16, 256 colors	640 x 480 pixels 2, 4, 16, 256, or 16.7 million colors
Apple Macintosh Portrait Display	640 x 870 pixels 2, 4, or 16 grays	640 x 870 pixels 2, 4, 16, or 256 grays
Apple Two-Page Monochrome Monitor	1,152 x 870 pixels 2, 4, or 16 grays	1,152 x 870 pixels 2, 4, 16, or 256 grays
Interlaced Video Devices	640 x 480 pixels 2, 4, 16, or 256 colors	640 x 480 pixels 2, 4, 16, 256, or 16.7 million colors (Apple Convolution enabled up to 256 colors)

System Requirements

To use the Macintosh Display Card 4•8, 8•24, or 8•24 GC, you'll need any Macintosh II personal computer with an available NuBus slot.

- System Software Version 6.0.5 or greater is recommended for the 4•8 and 8•24, and required for the 8•24 GC.

- For the Macintosh II, IIx, and IIcx, the 32-bit QuickDraw software is needed to run 24-bit color applications.

- To take advantage of full 24-bit color, a minimum of 2MB of memory is recommended.

✍

20

Overview: A/UX 2.0

A/UX Version 2.0 extends full Macintosh benefits to users who work with UNIX. While it retains the features of previous versions of A/UX—full compliance with UNIX standards and the ability to run Macintosh applications—A/UX 2.0 adds the graphics-based desktop of the Macintosh Finder™; the ability to run multiple UNIX, X Window System, and Macintosh applications simultaneously; and easy-to-use UNIX functionality.

As with previous versions, A/UX 2.0 is based on AT&T UNIX® System V, Release 2, Version 2. It runs Macintosh applications and complies with all major UNIX standards, including IEEE POSIX 1003.1 and 1988 FUS, AT&T System V Interface Definition (SVID), and FIPS #151. A/UX also meets standards for NFS (Network File System) Version 3.2, BSD 4.3 extensions, and the X Window System. What is new to A/UX Version 2.0, however, is that users who require UNIX now have full access to the benefits of the Macintosh, with A/UX 2.0 features that fall into three categories:

*   **The Macintosh desktop**

A/UX 2.0 offers all the elements of the Macintosh Finder desktop in a UNIX environment (see screen shot on right); it also supports the MultiFinder® environment, 32-bit QuickDraw, and the Macintosh startup and shutdown process. Familiar icons, applications in windows, menu-driven commands, and overall Macintosh maneuverability provide UNIX functionality on the desktop without users' needing to know the technical details of the environment.
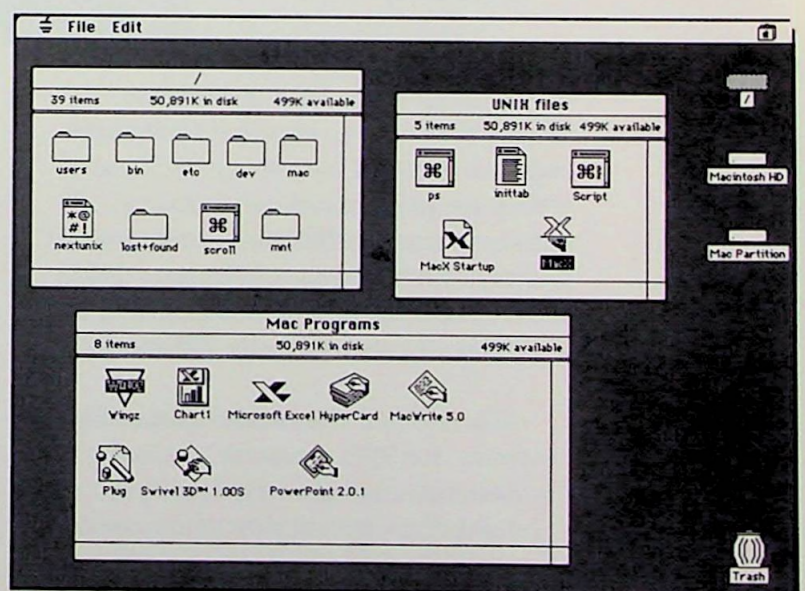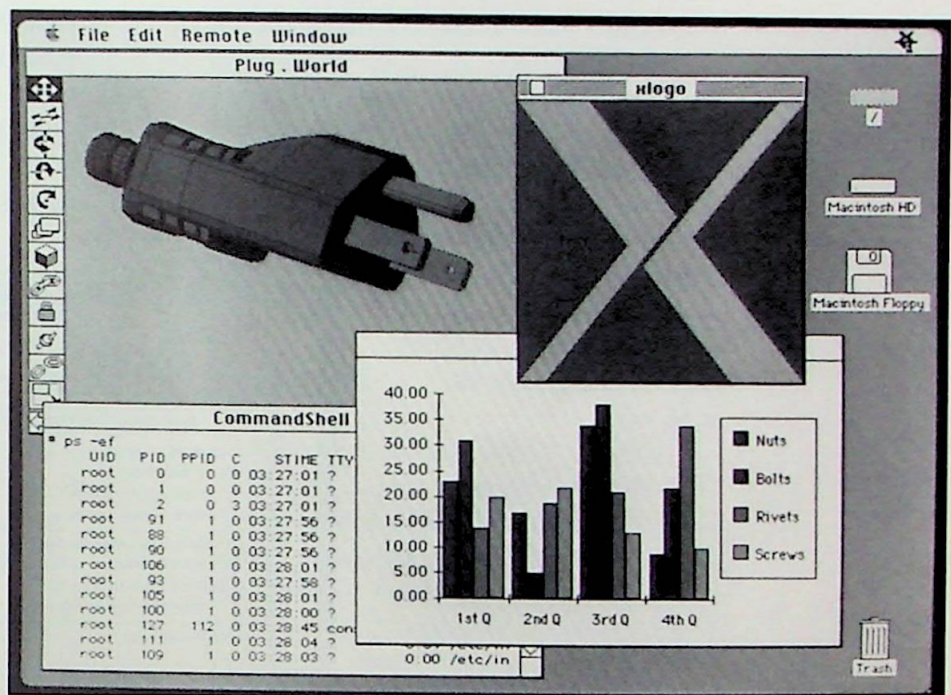
- **Multiple applications from different environments**

A/UX 2.0 users can run any number of UNIX, X Window System, and Macintosh applications under A/UX 2.0 at the same time. These applications can operate simultaneously on the desktop; users can cut and paste text among all applications, and cut and paste graphics among Macintosh applications.

The Macintosh Finder is the user environment for A/UX Version 2.0. From the Finder a user can launch Macintosh files, UNIX Toolbox applications, "vanilla" UNIX applications, and X Window System applications.

- **Easy-to-use UNIX functionality**

A/UX 2.0 integrates the benefits of both Macintosh and UNIX environments. Because UNIX users no longer have to learn the traditional command-line interface, A/UX makes UNIX accessible to mainstream users, while providing a standard UNIX environment. Both A/UX and Macintosh file systems appear on the desktop, and users have point-and-click access to all available files (eliminating the need for the HFX utility).

—The A/UX 2.0 "Commando" interface allows users to run UNIX commands by selecting options from a menu, without having to memorize the string of parameters associated with UNIX utilities. Dialog-based interfaces are

provided for all UNIX utilities that have command-line arguments. You have the choice of typing command-line arguments in the conventional way or invoking Commando. For example, if you double-click the UNIX command icon *ls*, you'll see the Commando dialog below:
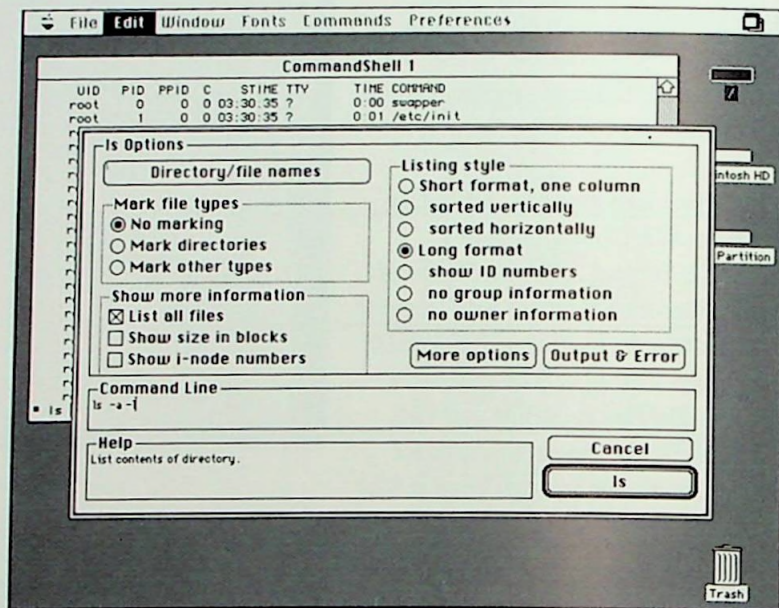
—A/UX 2.0 includes a new Macintosh text editor for UNIX text files, which provides point-and-click access to both UNIX and Macintosh file systems and eliminates the need to learn a text editor such as *vi*. (The standard editing and text processing utilities, including *vi, ex, ed, ditroff, nroff, tbl, eqn,* and *pic,* are available as alternatives.)

—A/UX 2.0 users also have the option to run UNIX in the traditional UNIX manner from within multiple "terminal" windows.

22

Other Product Details

A/UX 2.0 also includes the following features.

- **Multitasking and virtual memory support**

  A/UX 2.0 supports the execution of multiple processes simultaneously. Under MultiFinder, multiple Macintosh applications can run simultaneously, just as when using MultiFinder with the Macintosh operating system. At the same time, multiple UNIX and X Window applications can run in Macintosh windows. A/UX also provides virtual memory, allowing users to run more applications than the physical memory in the system can hold.

- **Macintosh applications execution**

  Macintosh applications that adhere to the specifications for the Macintosh 32-bit environment (referred to as "32-bit clean" applications), as documented in *Inside Macintosh,* run in the A/UX environment without change. (Support for 24-bit applications is also included as a transitional provision.) Most major Macintosh productivity applications, such as Microsoft Word 4.0, Wingz, MacWrite II, and HyperCard, are A/UX compatible. Macintosh Toolbox features—including printing, sound, and color—are supported in Version 2.0.

- **Communications**

  A/UX provides standard UNIX communications such as *cu* and *uucp,* as well as more advanced communications standards from UNIX (TCP/IP) and Macintosh (AppleTalk). Users can connect TCP/IP networks using Ethernet or serial lines

(SL/IP). With TCP/IP, users can take advantage of the X Window System, Berkeley Networking Services, NFS, and Network Information Services. Users can also connect to AppleTalk networks using EtherTalk® (sharing the Ethernet connection with TCP/IP protocols) or LocalTalk. With AppleTalk, users can take advantage of AppleTalk printing and AppleShare® file services (client only).

- **Programming**

  A/UX 2.0 offers an assembler, a C compiler, debuggers, the Source Code Control System (SCCS), an ANSI-standard FORTRAN compiler, and related tools to assist in developing new applications or porting existing software to A/UX. Version 2.0 also includes a set of UNIX libraries that allow C programs to access the functionality of the Macintosh Toolbox, so A/UX applications can present the graphics-based user interface that is familiar to Macintosh users, as well as the traditional UNIX appearance. Numerous other languages and tools are available from third-party developers.

- **AppleCD SC support**

  The AppleCD SC® drive can be used as a read-only UNIX or Macintosh hierarchical file system (HFS) of up to 500 megabytes, giving information systems providers an inexpensive distribution medium.

- **System administration**

  A/UX 2.0 simplifies configuration and recovery. It automatically configures the smallest kernel possible, and simplifies the manual addition of new drivers. In addition, A/UX 2.0 keeps

Hardware	Already supported in A/UX 1.1.1	New in A/UX 2.0
CPU	Macintosh SE/30 Macintosh IIcx Macintosh II with PMMU Macintosh IIx Macintosh IIci	Macintosh IIfx
Hard Disk	20MB, 40MB, 80MB, 160MB	
Floppy Disk Drive	400K, 800K	1.44MB
CD-ROM	UNIX file system format	Macintosh HFS
Printers	LaserWriter® IINT, IINTX LaserWriter ImageWriter® II, LQ	
Monitors	All Macintosh monitors Large color monitors from third parties	Apple Display Cards 4•8 and 8•24 GC
Keyboards	All domestic Macintosh keyboards (function keys not supported)	Nonextended European keyboards (function keys not supported)
Networking	TCP/IP over Ethernet SL/IP over serial lines AppleTalk 2.0 for A/UX optional	AppleTalk 2.0 for A/UX incorporated into A/UX 2.0 as a standard feature

redundant copies of crucial files so that, in the event of a damaging system crash, it can automatically return the system to a networkable state.

UNIX scripts are provided to aid in system administration functions such as connection of peripherals and modification of user information.

Hardware Support

A/UX 2.0 runs on the following Macintosh personal computers: Macintosh SE/30, Macintosh II (with PMMU), Macintosh IIcx, Macintosh IIx, Macintosh IIci, and Macintosh IIfx. The Macintosh IIfx is an especially powerful A/UX platform, because A/UX 2.0 takes full advantage of its SCSI/DMA and input/output processor capabilities. At least 4 megabytes of memory is required for any Macintosh system running A/UX.

A/UX 2.0 Compatibility

The chart on the left provides hardware and networking compatibility information for A/UX Version 1.1.1 and A/UX Version 2.0.

Upgrades

Existing A/UX users can upgrade to A/UX Version 2.0 by purchasing an A/UX Version 2.0 upgrade kit. Subscribers to the A/UX Update Program will receive A/UX 2.0 automatically.

Availability

A/UX Version 2.0 will be available in mid-1990 from all authorized Apple A/UX resellers. For the nameof the authorized A/UX reseller nearest you, call 1-800-538-9696.

✍️

A/UX Q&A

Q: How UNIX system standards compliant is A/UX?

A: A/UX is compliant with all the major U.S. standards, including AT&T's System V Interface Definition, IEEE's POSIX 1003.1 and 1988 FUS, ISO 9945-1, and the U.S. federal government's FIPS 151-1. A/UX also incorporates the most popular features of Berkeley Software Distribution 4.3. In addition, Apple includes de facto standards, such as NFS and NIS (formerly called "Yellow Pages") from Sun Microsystems, as part of the A/UX 2.0 package. Apple also offers an X Window System add-on product for A/UX 2.0.

Q: How does A/UX differ from other UNIX systems?

A: There are a number of important differences between A/UX and other implementations of UNIX. Most important, A/UX users have access to the broad range of Macintosh productivity applications. This is not true of any other system that runs UNIX. No other system that runs UNIX offers to the user the elegance and ease of the Macintosh desktop. In fact, many other companies are just beginning to create graphics-based interfaces for their UNIX systems. And finally, A/UX is a standard UNIX system (based on AT&T System V.2.2 and BSD 4.3), and many other UNIX systems are not.

Q: Which Macintosh applications run on A/UX? How can I tell which ones will run?

A: To run on A/UX 2.0 and to take full advantage of its virtual memory capabilities, Macintosh software applications must be "32-bit clean" (which means the software enables the Macintosh to access up to 4 gigabytes of virtual memory) and adhere to development guidelines set forth in *Inside Macintosh*. All key industry software developers are moving in this direction. Many already offer mainstream applications that are 32-bit clean and thus run on A/UX 2.0. These vendors includes Microsoft, Claris, Aldus,

and Informix. (A complete list is available from Apple.) As a transitional step, A/UX 2.0 also includes an optional 24-bit environment that allows users to run applications that are not yet 32-bit clean.

Q: What is the future direction of A/UX?

A: Our ongoing UNIX strategy is to bring the Macintosh vision of computing to people who work with UNIX. As a result, we will continue to incorporate UNIX standards as they emerge. We will also track Macintosh developments, including the upcoming System Software Version 7.0. We will also continue to work on tools to help users work creatively and efficiently with A/UX 2.0.

Q: What's the difference between A/UX and the standard Macintosh operating system?

A: A/UX and the Macintosh operating system are complementary operating systems. The Macintosh operating system brings distinct and compelling benefits for any individual or organization that wants to increase people's productivity through personal computing. A/UX is designed specifically for those individuals and organizations that want the productivity benefits that only Macintosh delivers but who require the UNIX platform. Another difference is that the Macintosh operating system requires less disk space and memory than does A/UX.

Q: Does A/UX completely shelter users from UNIX?

A: A/UX shelters users from typical UNIX functions (such as running applications, printing, and moving files) by letting them perform these activities in the distinctive Macintosh way: with icons, point-and-click access, and windows.

For the occasional system administration functions (such as configuring, backing up, and

adding user identifications) users need some traditional UNIX knowledge. As a result, the complete A/UX product includes a manual and default scripts that provide step-by-step instructions for these activities.

A/UX 2.0 also lets users operate their system in the traditional UNIX fashion. The standard C, Korn, and Bourne shells, along with all the AT&T System V 2.2 and major BSD 4.3 commands, can be used within windows on the A/UX desktop.

Q: Why do you need an 80MB hard disk to run A/UX?

A: A/UX is shipped on an 80MB hard disk because Apple provides the complete Apple UNIX system in one package. This is in contrast with other vendors, which remove pieces of the UNIX system from their base product offering and sell those elements separately. For example, IBM sells NFS, text editing, and other elements as separate products.

Q: What UNIX applications run on A/UX?

A: Many of Apple's A/UX customers use in-house UNIX applications that they have ported to A/UX. Because it's simple and fast for users to port UNIX applications to A/UX, Apple expects to see an increase in both traditional UNIX applications and emerging X Window System applications appearing on the A/UX platform. Apple also is constantly evangelizing developers to create new Macintosh applications.

Q: Does A/UX support all the Apple networking and communications products?

A: A/UX supports the primary communications standards for the UNIX and Macintosh worlds: TCP/IP and AppleTalk. In addition, A/UX includes the Macintosh Communications Toolbox, Apple's communications architecture for the Macintosh, which is designed to support Macintosh connectivity in key environments such as TCP/IP. In the future, as an extension of Macintosh Toolbox system software, the Communications Toolbox will consist of managers and tools that will easily provide applications with standard communications functions, including data connections, terminal emulation, and file transfer protocols. Apple will support other networking and communications standards with A/UX as is appropriate, and the company expects to see robust third-party activity in this area.

Q: What is the relationship between A/UX and System Software Version 7.0?

A: Since A/UX 2.0 will be released before Version 7.0, it is based on Version 6.0, in general. Apple is committed to tracking Macintosh and UNIX features as they emerge and will incorporate these features into later releases.

Q: Why is Apple supporting X and, via third party, Motif?

A: We support standards when it's clear that our customers want us to support those standards. Many of our customers have told us they wish to run X Window System and Motif applications when they become available—so we're supporting those standards. We view these products as additional tools for the A/UX users. As such, we have provided additional features over and above X Window System to aid our customers: integration with the desktop, text cut and paste to the Scrapbook, and easy launch of applications.

Q: What services does Apple provide for resolution of more complex A/UX issues?

A: Apple's Technical Answerline is available by subscription. See the following information for more details.

Apple Technical Answerline

The Apple Technical Answerline is designed to give you direct access to Apple support engineers for technical assistance with high-end Macintosh computer products for a yearly fee. The flexible subscription options allow you to choose the type of support you need: networking and communications only, A/UX only, or both.

Your calls to the Technical Answerline go directly to a knowledgeable support engineer who has been trained extensively on the latest Apple networking, communications, and A/UX products.

The Answerline engineers handle questions on issues such as configuration, installation, compatibility, usage, administration, and troubleshooting.

If you choose the Networking and Communications subscription option, you'll receive assistance with products such as AppleTalk products (including AppleShare PC, AppleTalk for VMS™, and AppleTalk Internet Router), IBM-compatible networking and connectivity products (such as Apple TokenTalk® NB Card and TokenTalk software, Apple Serial NB Card, Apple Coax/Twinax Card, Apple EtherTalk® NB Card, and EtherTalk software), and Integration products (MacAPPC™, MacX25™, Macintosh Communications Toolbox, MacWorkStation™, and CL/1™).

The A/UX subscription option will provide assistance with the following A/UX products: A/UX, X Window System, MacX™, AppleTalk for A/UX, and EtherTalk for A/UX.

Answerline support is available from 6:00 A.M.. to 6:00 P.M. Pacific time, Monday through Friday, except for selected holidays. For more information on the Apple Technical Answerline, or for a Support Services order form, contact your authorized Apple reseller or sales representative.

Overview: MacWorkStation Version 3.1

MacWorkStation (MWS) Version 3.1 is a server application that runs on a Macintosh computer and provides standard Macintosh user interface, printing, and filing services to client applications running on remote computers. Client applications can be written in any language and run on any host or personal computer connected over a wide variety of network and communications protocols. Host applications can provide a graphical user interface while reducing host CPU processing and communications loads.

MacWorkStation provides two primary benefits: high-level access to the Macintosh Toolbox and a framework for building cooperative Macintosh-to-host applications. Programmers have full access to and control over windows, pull-down menus, dialog boxes, and other features of the Macintosh user interface—without having to learn the details of a traditional Macintosh programming environment.

The maintenance of all the standard objects is handled locally by the MacWorkStation server, without host processing or the need for the host programmer to learn how to program a graphical user interface. The host application remains centrally controlled and updated, while distributing the heavy processing required to support a graphical user interface to the desktop. Executable code modules on the Macintosh allow distribution of the application logic to achieve a true cooperative application.

Message Protocols

The MWS protocols are text based to ensure transparency through protocol converters and through communication networks. Messages are either commands or events; commands are messages sent from the client application requesting an action on the Macintosh, and events are messages sent from MacWorkStation informing the client of a significant change of state (such as buttons being pressed, or pull-down menu commands being executed). Transaction Layer Protocol Modules (TLPMs) can be written to handle communications between the network and the MacWorkStation server. Serial and AppleTalk TLPMs are provided with the product; other TLPMs, including TCP/IP, DECnet™, and 3270, are provided by third parties.

Director Suites	Presentation Directors (Windows, Menu, Graphics, etc.)	File	Exec	Future Directors Provide Additional Services
	Communications Connection Language			
	MacWorkstation Main Module			
Communications Modules	TTY	ADSP	3270	OSI	Future Communications Modules

MacWorkStation Architecture

☐ Future support
▨ 3.1
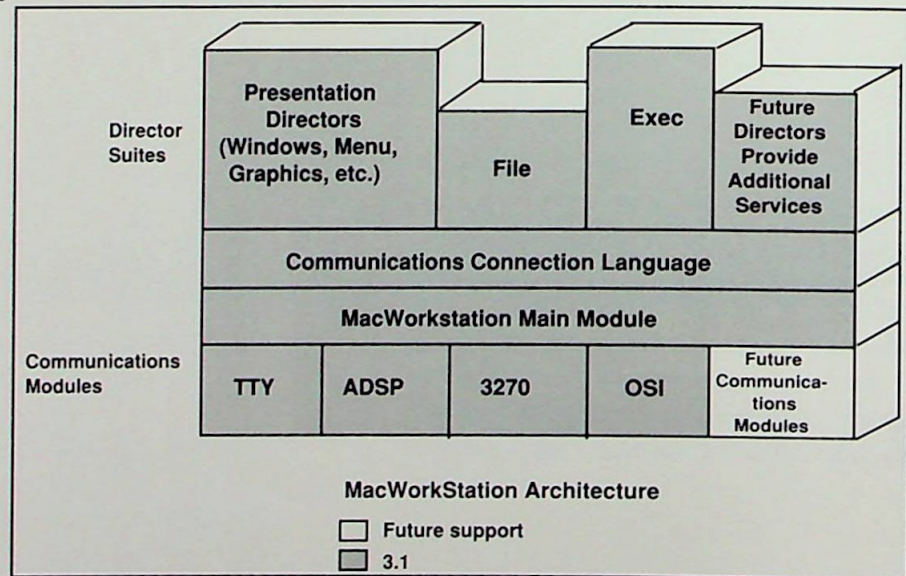
The MacWorkStation environment is discussed in the following paragraphs and is illustrated above.

Directors

Directors act as a high-level Toolbox that interprets commands from the host to build and maintain the Macintosh user interface and filing and printing objects. Directors use the underlying Macintosh Toolbox Managers to support a consistent environment between host and local applications. Directors include Alert, Dialog, Graphics, Window, Cursor, Menu, List, and File. (Other Directors can be added.)

Distributed Architecture

Distributed architecture reduces host and communication needs. By distributing the creation, updating, and maintenance of user interface objects to the Macintosh, host processing is significantly reduced. Graphic objects such as menus and dialogs can be stored locally without having to be re-created over and over again from the host. Because the host program is only providing the "directions" for building the user interface, MacWorkStation can effectively provide the same user interface over 19.2K-baud or 1200-baud communication rates.

Exec Modules

Exec Modules constitute a Macintosh code resource that can be created from any high-level Macintosh programming language and added to the MacWork-Station application document. One or more Exec Modules can be launched locally (or by the host) and may perform any task. Exec Modules run simultaneously and can trap events or interact with the host or user while MacWorkStation is running, providing a powerful way of extending and customizing MacWorkStation to fit a wide range of cooperative processing needs. Exec Modules can also use MacWorkStation commands to perform any user interface, printing, or file-management functions. This reduces the amount of knowledge needed by an Exec Module programmer.

Communications Connection Language (CCL)

CCL is a powerful scripting language built specifically to help access remote applications. The CCL script can be lengthy and complex or it can be very short, depending on how the user is accessing the client application. Once the client application is reached, the CCL script transfers control of the session to the host application.

MWS Utility Programs

MWS Dialog Builder allows a programmer to quickly "paint" dialog boxes and store them for use by the client application. The utility is easy to use, and allows the building of dialogs from a palette of objects. MWS Event Handler™ allows quick prototyping of a MacWorkStation application by generating commands in response to MacWorkStation events. In effect, MWS Event Handler acts as the client application. The combination of MWS Event Handler and MWS Dialog Builder allows the quick design of the application's user interface.

Implementation

Using MacWorkStation to develop a Macintosh interface on an application requires that the host software be modified in one of two ways:

- If the application has been written with a separate module to manage the terminal or user interface, a replacement Macintosh interface module can be written to manage the interaction between the host application and MacWorkStation.

- If the application has been written to include the terminal-handling function as an integral part, the application must be modified to support MacWorkStation directly.

Apple Software Licensing
20525 Mariani Avenue, M/S 28B
Cupertino, CA 95014
(408) 974-4667

System Requirements

To use MacWorkStation, you must have a Macintosh Plus, Macintosh SE, or Macintosh SE/30 personal computer, or any computer in the Macintosh II family.

Availability

Single-user versions of MacWorkStation 3.1 and the MacWorkStation Utility Programs and Communications Modules are available through the Apple Programmers and Developers Association (APDA™). An organization license for MacWorkStation is available through Apple Software Licensing.

APDA
Apple Computer, Inc.
20525 Mariani Avenue, M/S 33G
Cupertino, CA 95014
1-800-282-2732 (United States)
1-800-637-0029 (Canada)
(408) 562-3910 (other countries)
AppleLink: APDA

Overview: X Window System and MacX

This article describes the X Window System and MacX, Apple's implementation of an X Window display server under the Macintosh operating system and A/UX.

What is X Window?

In 1984, the Massachusetts Institute of Technology (MIT) started a project to investigate the use of networked graphics workstations as teaching aids. Several vendors were involved in the project, making a hardware-independent protocol necessary for communication. The result was the X Window System.

Starting in 1986, X Window System Version 10, Release 4 was licensed to interested parties for a nominal charge. With support from various computer firms, including Digital Equipment Corporation, the system has become the de facto industry standard for windowing between workstations—especially for UNIX system–based scientific applications.

The X Window System is a distributed, network-transparent, device-independent graphics and windowing system. It permits multiple windows to be displayed and manipulated on a workstation, much as the Macintosh Finder does on Macintosh screens. Unlike the Finder, a window can be driven by an X Window application running on a different computer across the network. Such applications are called clients. Clients may be started from any machine and client output can be redirected to any other X Window display server or screen.

Network transparency and device independence are derived from standardizing on a communications protocol called X. X Window is network transparent because the X protocol is a presentation-level protocol that can be carried by any transport protocol, such as TCP/IP, DECnet, or the AppleTalk network. Thus, workstations can use X Window over Ethernet, LocalTalk, and other network types as long as the network bandwidth is sufficient to carry the traffic generated.

The main benefit of the X Window System is to allow applications interoperability between computers from different vendors. With the appropriate software, X allows users to share resources across the network, regardless of the resource's hardware or operating system architecture.

X Window Architecture

The X definition of *server* is the reverse of the usual usage of the word. Typically, the server is a shared device from which network services can be obtained. From the user's perspective, the server is remote from the workstation.

In the X system, however, the shared device is the display—the individual workstation. From the user's perspective, the workstation is the server with clients on the network.

The X Window System has two parts, each of which is individually layered. (See diagram on the following page.) The X Server function is to share the display among many clients and to interact with the user—which implies drawing windows on the screen(s) and returning keyboard or mouse input to the appropriate clients.

The client is an application program making requests to the server to draw windows, text, and

graphics. It responds to user input which is transmitted by the server as keyboard or mouse events.
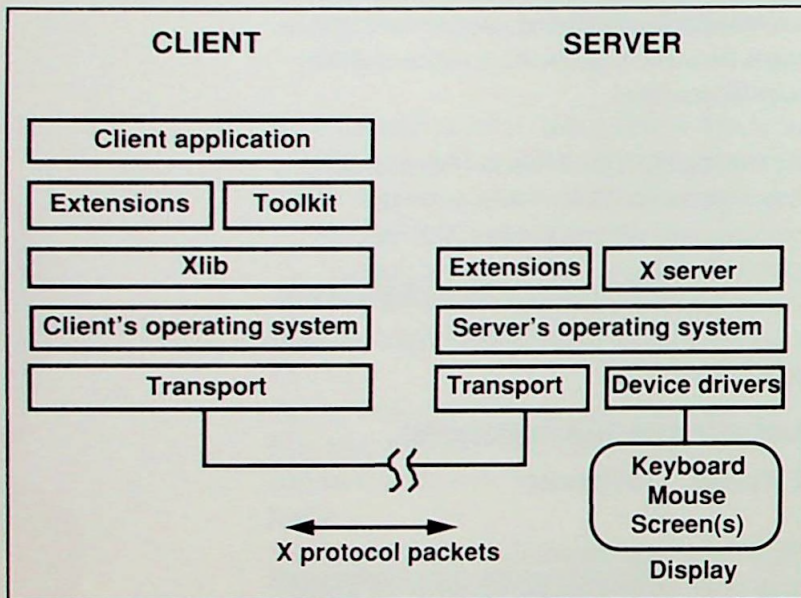

Figure 1: X Window Architecture

Note that the X system allows for extensions by defining a mechanism to add extensions beyond those functions defined by the standard. Such extensions work similarly to the core Xlib routines, but usually perform much more complex functions. Among the extensions being developed are support for three-dimensional graphics (PEX) and Imaging Extensions (XIE).

X Display Server

The X display server—or workstation—supports multiple clients (user programs) running on either local or remote systems, and performs the following functions:

- Allows access to the display by multiple applications.

- Interprets network messages.

- Passes user input to the appropriate clients.

- Generates two-dimensional graphics as specified by clients.

- Maintains data structures, such as windows, cursors, and "graphic contexts," which can be shared between applications via resource IDs.

When the traditional X display server is started, the entire display is covered by a root window. (If there are multiple screens in the display, each screen will be covered by a separate root window.) This window is always visible and borders all the client windows.

X Clients

Clients are applications that communicate with an X display server. Client operation can be local (on the same machine as the X display server) or remote (on any machine accessible via the network).

To make the job of the client applications programmer easier, most of the low-level procedures necessary for an X client are provided in the X toolkit. The toolkit procedures then make calls to a library of functions called Xlib, and the Xlib functions generate a data stream encoded in the X protocol format. Following are details about each client layer.

- **X toolkit**

A set of procedures employs Xlib functions to provide graphic features such as dialog boxes or scroll bars. The basic data types are called "widgets"—active elements that retain information about the graphic state of objects. Widgets respond to

input from the display server's mouse or keyboard and alter the display appearance as the corresponding output. For example, pop-up widgets are used to represent dialog boxes and other interactive components.

Several toolkits are available in the public domain. MIT's X Window distribution tape provides a toolkit called Xt (called Xtk before X11 Release 2), developed by Digital and MIT.

- **Xlib**

Xlib is a collection of more than 200 functions, many of which resemble primitives found in a graphics library (such as XDrawRectangle and XFillRectangle). The functions connect to a display server, create windows, draw graphics, and respond to events.

- **X protocol**

X protocol is a low-level graphics-description language. At run time, the calls to the Xlib generate X protocol requests to be sent to the X server. The requests are variable-length packets beginning with a 1-byte op code that identifies the type of request. The next field is a 1-byte data field associated with the op code instruction. The data field is followed by a 2-byte field specifying the entire length of the packet in 4-byte units. One or more bytes of data follow.

In response to client requests, the X server sends back a 32-byte or longer reply packet. All requests sent during a particular connection are sequentially numbered so that replies can be matched to the request. Round-trip messages are kept to a minimum to speed up the communications.

Client Examples

Some clients, such as *xclock* (shows the time in analog or digital format) and *xcalc* (scientific calculator), have functions similar to those of Macintosh desk accessories. Other clients, such as *xwd* (stores image in formatted window dump file) and *xpr* (takes *xwd* dump file and converts it to PostScript® format) handle printing functions. Many other clients perform a wide variety of functions.

Two common X clients are the X Window manager and the X terminal emulator.

- **X Window manager**

X Window managers are specific clients used to control certain aspects of other clients' windows (title bars, grow boxes, and so on). You can change size, position, and other window attributes with a window manager. The most common window manager is *uwm*, or Universal Window Manager, provided by MIT. The *uwm* window manager performs the following operations on the screen:

- Allows movement of windows.

- Changes the size of the windows.

- Rearranges the order of overlapping windows.

- Converts windows to icons and back again.

- Refreshes the screen.

- Provides adornments to windows (title bar, grow boxes, and so on).

The X Window manager should not be confused with the Macintosh Window Manager. Though they share many similar characteristics, they are separate

entities. The Macintosh Window Manager is part of the Toolbox in the Macintosh operating system. The X Window manager is an application that serves a similar function, but only for the X Window display server.

The X Window System does not specify a particular user interface. The screen layout or appearance and the style of user interaction ("look and feel") are provided by each vendor's X Window manager and toolkit. The window manager is responsible for the outside of the window (title bar, close box, and so on), and the toolkit is responsible for the inside of the window (scroll bars, radio buttons, and so on).

Because X Window designers wanted to avoid window management "policy" issues, X servers can be run without a window manager or with *uwm*, Motif, or any other window manager. Some people argue that the lack of policy dilutes the appeal of X as a standard user platform because it forces users to learn a vendor-specific user interface. Others feel that the freedom to choose a user interface allows the marketplace to create better designs.

- **Terminal emulator (*Xterm*)**

Xterm, a popular terminal emulator for the X system, emulates either a Digital VT102™ or a Tektronix 4015 terminal. The *Xterm* client brings up a window that allows you to log in to the host system. *Xterm* also allows the use of applications designed to run on standard alphanumeric terminal displays.

MacX: Macintosh X Window Display Server

MacX is an X Window display server for the Macintosh. Compatible with MultiFinder and A/UX, MacX allows you to take advantage of the X Window System in conjunction with the user interface of the Macintosh. Two operating modes—rooted and rootless—each have color and monochrome support. In the rooted mode, any X Window manager can request to manage client windows attached to rooted windows. In the rootless mode, the client windows look like any other window on the Macintosh desktop, as shown in the Figure 2.
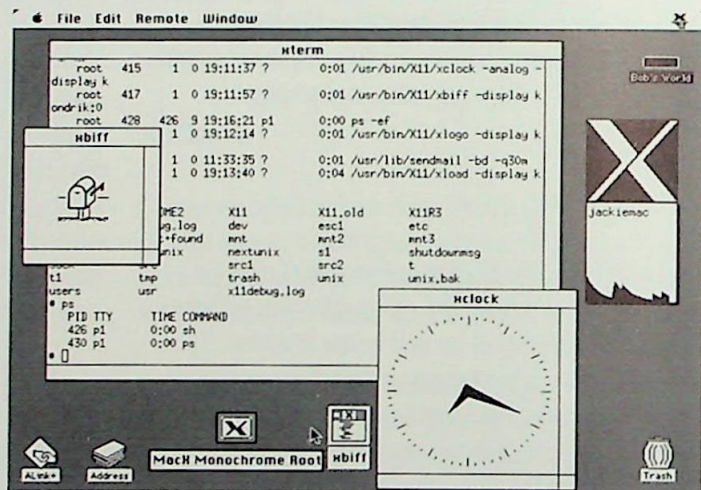
Figure 2: MacX Display Server

MacX supports the latest release of X Window: Version 11 Release 4. (Release 4 additions include isolation of individual client requests and inclusion of DECW$CURSOR and DECW$SESSION fonts.)

- **Window types in rootless mode**

The MacX application supports five different window types, as shown in Figure 3.
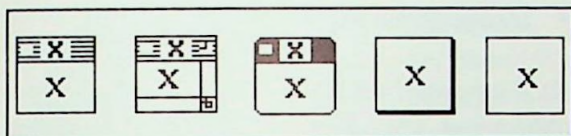
Figure 3: MacX Window Styles

The two window styles shown at the extreme right of Figure 3 do not have title bars, preventing the windows from being moved. However, a title bar can be temporarily applied by a menu selection under Windows; it will be removed after the first mouse click. And if you hold down the Option key, you can drag any window from anywhere on the window.

MacX supports such *rootless* windows on the desktop. This means that the client windows are not bounded by a rooted window; they can appear anywhere on the desktop with the Macintosh Window Manager as their parent. You choose the window type at time of client initiation or change the type later with a menu command. Clients may select their own window types as well.

For applications that require a rooted window, a color or monochrome rooted window can be specified from the MacX menu. Windows have a maximum size of 2,048 by 2,048 pixels. If a rooted window is required by a client (and one is not already displayed), a Macintosh window will appear containing the root and its client windows (unless this feature is disabled).

MacX permits rootless clients and root windows to be displayed as icons (for rooted clients, the process is handled by the window manager in use for that particular root), allowing you to clear up clutter on the desktop. Double-clicking on the icon or choosing the appropriate menu item redisplays the window.

- **Font management**

MacX supports standard MIT fonts, as well as DECwindows™, Macintosh, and Adobe Bitmap Distribution Format (BDF) fonts. Each font type is distinguished by a different icon preceding its name in the Font Director window, and is accessed by an item under the Edit menu.

Some of the BDF fonts are distributed on the MIT X Window release tape; to be used with MacX, they must be compiled by the MacX Font Director. The MacX product includes precompiled BDF fonts.

All fonts must be kept in a folder named "MacX Fonts," and the folder must be located in the System Folder. When you first install it, MacX scans for available fonts and builds a file called the Font Directory, which goes in the MacX Fonts folder. Whenever the modification date of this folder changes, as it does each time you start the MacX application, the Font Director updates the Font Directory.

In the X Window System, font naming is cumbersome. The following is a sample font entry:

Adobe-Times-Medium-R-Normal-10-100-75-75-P-54-ISO8859-1

The entry includes such information as the registered owner of the font, foundry type, family name, and weight. Because of this complex naming scheme, MacX allows an alias to be assigned to a font.

The MacX Font Director also displays a sample of a selected font (similar to the Font/DA Mover); other X Window systems require running a font-viewing client.

- **Color management**

MacX provides a color naming scheme. A MacX dialog box associates an alphanumeric name with each color; the name can be used to specify a color when calling a client. In most other X servers, colors are represented in a numeric format that indicates amounts of red, green, and blue (RGB values). MacX addresses color selection by providing a color wheel dialog box, which is the same as the Color Wheel used in the Control Panel. You have the option of selecting a color from the palette or specifying it numerically.

- **Network connectivity**

MacX requires the Macintosh Communications Toolbox, which allows multiple simultaneous connections over different transport protocols. Communications tools are provided to support TCP/IP. When connecting to VAX™/VMS hosts to run DECwindows applications, AppleTalk ADSP (AppleTalk Data Stream Protocol) and DECnet protocols can also be used. DECnet support will be offered by Alisa Systems as part of TSSnet Version 2.0. Digital is also planning to release an implementation of DECnet for the Macintosh by late summer of 1990.

- **Screens**

MacX supports multiple color and monochrome screens. Because it is MultiFinder compatible, MacX also supports cut and paste of text and graphics between X applications and local applications. Since clients may have a different way to implement cut and paste, the Macintosh Command-key equivalents might not work. However, cut and paste can be achieved by the MacX standard cut/paste buffer and the appropriate commands for/from the client.

- **International support**

MacX supports the X Window standard ISO Latin-1 character set, which handles international characters and is mapped differently than is the Macintosh Extended ASCII character set. You access international characters via the Option key. When you cut and paste data between the X world and the Macintosh world, MacX takes care of converting between character sets.

System Requirements

To use MacX, you'll need the following:

- A Macintosh Plus, Macintosh SE, or Macintosh SE/30 computer, or any computer in the Macintosh II family

- At least 2 megabytes of memory

- Two floppy disk drives, or one floppy disk drive and a hard disk (a hard disk is highly recommended)

- Macintosh System Software Version 6.0.4 (or greater)

- A network connection (using the built-in LocalTalk port in the Macintosh or an Ethernet connection)

Availability

MacX is available as a stand-alone product or as part of the X Window System for A/UX Version 2.0, which will be available in mid-1990.

✍

Introducing the Apple Technical Information Source CD-ROM
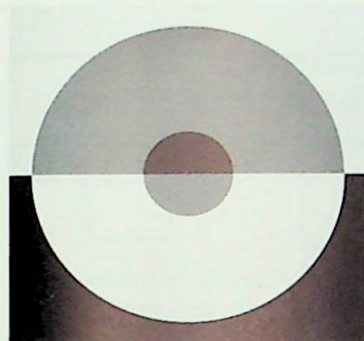
Technical Information Source

The Apple Technical Information Source is a CD-ROM-based technical information retrieval product that provides a broad range of technical support tools and information for Macintosh and Apple II systems. It's designed to help support providers—including resellers, in-house support organizations, systems integrators, and independent support contractors—furnish top-quality assistance to users of Apple computers.

The Technical Information Source provides fast, fingertip access to technical databases, frequently used system utilities and diagnostics, and a wide range of support-oriented HyperCard stacks—all tied together with a HyperCard front end that makes it easy to navigate the 200 megabytes of information.

Benefits to Support Providers

The Technical Information Source collects most of the tools and information a support provider needs in a large-capacity (550MB) CD-ROM format. All the information is accessible through a single user interface—a HyperCard front end that provides fast and intuitive navigation. Because CD-ROM is a read-only medium, there is no risk of accidental erasure or infection by a computer virus.

The information will be updated regularly to keep you up to date without stacks of disks and papers. And because the Technical Information Source can be configured as an AppleShare volume, tools and

information can be shared by everyone on the network, increasing the value of your investment in the AppleCD SC drive and the Technical Information Source, and decreasing the demands on individual support providers.

The Technical Information Source will help you find answers more quickly, and you'll be less dependent on others, with answers and solutions at your fingertips. The product is designed to make you more productive in the short run, and more knowledgeable about Apple solutions in the long run.
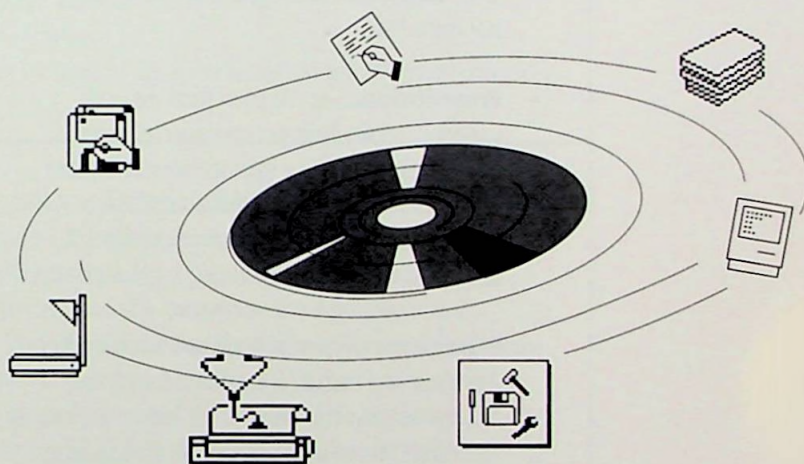
Product Details

The Technical Information Source is organized into these major categories:

- **Applications.** Apple and third-party applications, along with demonstration and Guided Tour files, allow you to emulate user problems with applications you may not have, and help you advise users on which solutions best meet their needs.

- **Copy Center.** Disk images of most of the 3.5-inch disks released by Apple allow you to replace users' disks quickly and easily. Included are current and historical versions of Macintosh, Apple IIGS, and Lisa® system software, peripheral drivers, Guided Tour disks, system utilities, and more.

- **Diagnostics.** Software and network-related diagnostics for troubleshooting users' problems include programs such as NodeCheck™, AppleTalk Peek, and AppleTalk Poke. (Hardware diagnostics used by service technicians are not included.)

- **Presentations.** Apple presentations on a variety of topics help you prepare technical presentations for your management and other departments in your organization. Topics include networking, connectivity, and A/UX, and come with building blocks, such as clip art.

- **References.** HyperCard stacks and other files that present a broad foundation of technical references help you prepare for future questions and direct you to other sources of information and support.

- **Technical Information.** A technical database provides answers to questions that have been asked by support providers like yourself. A HyperCard front end and search capabilities allow you to look quickly through more than 3,000 articles.

- **Training.** Self-paced training stacks on most Apple computers and peripherals help new users train themselves, freeing up your time for other support activities.

- **Utilities.** Frequently used system utilities include the Apple File Exchange, Font/DA Mover, and ResEdit™, centralized to help you find the program you need to solve a particular problem.

- **Additional Features.** On-line help and keyword search help you locate what you need, and a built-in feedback mechanism allows you to send in suggestions for design changes and content enhancements.

System Requirements

To use the Technical Information Source CD-ROM, you'll need the following:

- A Macintosh Plus or greater, with a minimum of 1 megabyte of memory (2 megabytes recommended)

- AppleCD SC drive

Ordering Information
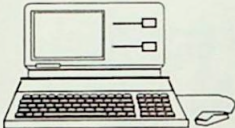
For a demonstration of the Technical Information Source, contact your local authorized Apple reseller or Apple representative, or pick up a copy of the May issue of *MacUser* magazine, in which you'll find an Apple ad that offers a free CD-ROM sampler of the Technical Information Source.

To purchase the Technical Information Source, see your authorized Apple reseller or your Apple representative.
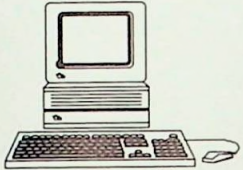
✍

Macintosh System Software Compatibility and Configuration

CPUs	Macintosh System Software Compatibility and Configuration
Macintosh 128K	• Currently ships with: Product no longer available from Apple. • Supports: System Software 2.0 and Finder 4.1. • Recommended: System Software 2.0 and Finder 4.1. • For AppleShare: Cannot be used as an AppleShare file server or workstation.
Macintosh XL	• Currently ships with: Product no longer available from Apple. • Supports: System Software 1.0 and System Software 1.1. • Recommended: System Software 1.1. • For AppleShare: Cannot be used as an AppleShare file server or workstation.
Macintosh 512K	• Currently ships with: Product no longer available from Apple. • Supports: System Software 1.0 and System Software 1.1. • Recommended: System Software 1.1. • For AppleShare: The Macintosh 512K cannot use the AppleShare 2.0 workstation software. You can still use the AppleShare workstation software Version 1.1 with a file server that uses AppleShare File Server 2.0, although you will not be able to take advantage of the new features of AppleShare File Server 2.0. System Software 3.3 and Finder 5.5 are installed by the AppleShare 1.1 Workstation Installer disk.
Macintosh 512K Enhanced	• Currently ships with: Product no longer available from Apple. • Supports: System Software 1.0, System Software 1.1, System Software 2.0, and System Software 2.0.1. • Recommended: System Software 2.0.1. • For AppleShare: System Software 3.3 and Finder 5.5 are installed by the AppleShare 1.1 Workstation Installer disk; System Software 3.4 and Finder 6.1 are installed by the AppleShare 2.0 Macintosh 512K Enhanced Workstation Installer disk. This machine cannot be used as an AppleShare file server.

CPUs	Macintosh System Software Compatibility and Configuration
Macintosh Plus	• Currently ships with: System Software 6.0.4. • Supports: System Software 1.0 through System Software 6.0.4. • Recommended: System Software 6.0.2 or later. • For AppleShare: System Software 2.0 or later; System Software 6.0.2 or later is recommended.
Macintosh SE	• Currently ships with: System Software 6.0.4. • Supports: System Software 2.0 through System Software 6.0.4. • Recommended: System Software 6.0.2 or later. • For AppleShare: System Software 2.0 or later; System Software 6.0.2 or later is recommended.
Macintosh SE/30	• Currently ships with: System Software 6.0.4. • Supports: System Software 6.0.3 and System Software 6.0.4. • Recommended: System Software 6.0.3 or later. • For AppleShare: System Software 6.0.3 or later.
Macintosh II	• Currently ships with: System Software 6.0.4. from Apple. • Supports: System Software 2.0 through System Software 6.0.4. • Recommended: System Software 6.0.2 or later. • For AppleShare: System Software 2.0 or later; System Software 6.0.2 or later is recommended.
Macintosh IIx	• Currently ships with: System Software 6.0.4. • Supports: System Software 6.0.3 and System Software 6.0.4. • Recommended: System Software 6.0.3 or later. • For AppleShare: System Software 6.0.3 or later.

CPUs	Macintosh System Software Compatibility and Configuration
Macintosh IIcx	• Currently ships with: System Software 6.0.4. • Supports: System Software 6.0.3 and System Software 6.0.4. • Recommended: System Software 6.0.3 or later. • For AppleShare: System 6.0.3 or later.
Macintosh Portable	• Currently ships with: System Software 6.0.4. • Supports: System Software 6.0.4. • Recommended: System Software 6.0.4. • For AppleShare: System Software 6.0.4.
Macintosh IIci	• Currently ships with: System Software 6.0.4. • Supports: System Software 6.0.4. • Recommended: System Software 6.0.4. • For AppleShare: System Software 6.0.4.
Macintosh IIfx	• Currently ships with: System Software 6.0.5. • Supports: System Software 6.0.5. • Recommended: System Software 6.0.5. • For AppleShare: System Software 6.0.5.

System and Finder versions of System Software releases:

Release	System Version	Finder Version	Release	System Version	Finder Version
System Software 1.0	System 3.2	Finder 5.3	System Software 6.0	System 6.0	Finder 6.1
System Software 1.1	System 3.2	Finder 5.3	System Software 6.0.2	System 6.0.2	Finder 6.1
System Software 2.0	System 4.1	Finder 5.5	System Software 6.0.3	System 6.0.3	Finder 6.1
System Software 2.0.1	System 4.1	Finder 5.5	System Software 6.0.4	System 6.0.4	Finder 6.1.4
System Software 5.0	System 4.2	Finder 6.0	System Software 6.0.5	System 6.0.5	Finder 6.1.5
System Software 5.1	System 4.3	Finder 6.0			

Current Macintosh Software, Hardware, and Upgrades

Thanks to the AppleGram™ staff for developing the following charts, which contain information about:
—The version of operating system software recommended for each of Apple's hardware products
—Current upgrade options available from Apple

For additional information about upgrades and updates, see page 49.

Macintosh System Software

System/Finder™	Macintosh Plus	Macintosh SE	Macintosh SE/30	Macintosh II	Macintosh IIx	Macintosh IIcx	Macintosh IIci	Macintosh IIfx	Macintosh Portable
3.2/5.3	2								
3.3/5.4	3								
4.0/5.4	2	2							
4.1/5.5	2/3	2/3		2/3					
4.2/6.0	2/3	2/3		2/3					
6.0.2/6.1	2/3	2/3		2/3					
6.0.3/6/1	2/3	2/3	2/3	2/3	2/3	2/3			
6.0.4/6.1	1/4	1/4	1/4	1/4	1/4	1/4	1/4		1/4
6.0.5/6.1.5								1/4	

1 = Best system software for the hardware model
2 = Fine to use with hardware model
3 = Fine to use with AppleShare
4 = Best system software to use with AppleShare 2.0.1 (use the Installer)

HyperCard

HyperCard	• Version 1.2.2 (with System 6.0.3 or earlier)
	• Version 1.2.5 (with System 6.0.4 or greater)

Macintosh Upgrades

	Macintosh Plus	Macintosh SE	Macintosh SE/30	Macintosh II	Macintosh IIx	Macintosh IIcx	Macintosh IIci	Macintosh IIfx	Macintosh Portable	
68851 PMMU				•						Logic Board Upgrades
Macintosh SE/30 Logic Board Upgrade		•								
Macintosh IIx Logic Board Upgrade				•						
Macintosh IIci Logic Board Upgrade						•				
Macintosh IIfx Logic Board Upgrade				•	•					
1MB Memory Exp. Kit			•	•	•	•	•		•	Internal Memory
2MB Memory Exp. Kit	•	•								
4MB Memory Exp. Kit			•	•	•	•	•			
4MB Parity Memory Expansion Kit							•[1]	•[1]		
EtherTalk NB Card				•	•	•	•	•		Network Cards
TokenTalk NB Card				•	•	•	•	•		
Coax/Twinax Card				•	•	•	•	•		
Serial NB Card				•	•	•	•	•		
Apple Personal Modem (1200 bps)	•	•	•	•	•	•	•	•	•	Modems
Apple Data Modem 2400	•	•	•	•	•	•	•	•	•	
AppleFax™ Modem	•	•	•	•	•	•	•	•	•	
Macintosh Portable Data Modem 2400									•	Portable Options
Rechargeable Battery									•	
External Battery Recharger									•	
Numeric Keypad Module									•	

[1] The parity option for the Macintosh IIci and IIfx is available only at time of purchase; parity cannot be added to either CPU at a later date.

Macintosh Drives

	Macintosh Plus	Macintosh SE	Macintosh SE/30	Macintosh II	Macintosh IIx	Macintosh IIcx	Macintosh IIci	Macintosh IIfx	Macintosh Portable	
Macintosh Internal 800K Floppy Drive		•	•	•	•	•	•	•	•	**Internal Drives**
Macintosh Internal 1.4MB SuperDrive		•		•	•			•		
Macintosh Internal Hard Disk 20SC		•	•	•	•	•	•	•		
Macintosh Internal Hard Disk 40SC		•	•	•	•	•	•	•		
Macintosh Internal Hard Disk 80SC		•	•	•	•	•	•	•		
Macintosh Internal Hard Disk 160SC				•	•		•			
Macintosh Portable Internal Hard Disk 40SC								•		
Macintosh External 800K Floppy Drive	•	•	•			•	•		•	**External Drives**
Macintosh External 1.4MB SuperDrive		•[1]	•			•	•		•	
Macintosh External 5.25 PC Drive		•		•	•	•		•		
Macintosh External Hard Disk 20SC	•	•	•	•	•	•	•	•	•	
Macintosh External Hard Disk 40SC	•	•	•	•	•	•	•	•	•	
Macintosh External Hard Disk 80SC	•	•	•	•	•	•	•	•	•	
Macintosh External Hard Disk 160SC	•	•	•	•	•	•	•	•	•	
AppleCD SC (CD-ROM Drive)	•	•	•	•	•	•	•	•	•	
Apple Tape Backup 40SC	•	•	•	•	•	•	•	•	•	

[1]Beginning in September 1989, all standard Macintosh SE computers have included the 1.4MB SuperDrive floppy disk drive. Macintosh SE systems with the original 800K drives can be upgraded to include the SuperDrive. Until this upgrade is done, the external SuperDrive will NOT work with the older, 800K-based Macintosh SE.

Macintosh II Displays and Display Cards

	Macintosh II	Macintosh IIx	Macintosh IIcx	Macintosh IIci	Macintosh IIfx	
Apple High-Resolution Monochrome Monitor (12 inches)	●[1]	●[1]	●[1]	●[2]	●[1]	**Macintosh Displays**
Apple Two-Page Monochrome Monitor (21 inches)	●[1]	●[1]	●[1]	●[1]	●[1]	
Apple Macintosh Portrait Display (15 inches)	●[1]	●[1]	●[1]	●[2]	●[1]	
AppleColor High-Resolution RGB Monitor (13 inches)	●[1]	●[1]	●[1]	●[2]	●[1]	
Macintosh II Monochrome Video Card	●	●	●	●	●	**Macintosh Display Cards**
Macintosh Display Card 4•8 (available May 1990)	●	●	●	●	●	
Macintosh Display Card 8•24	●	●	●	●	●	
Macintosh Display Card 8•24 GC	●	●	●	●	●	
Macintosh Display Card VRAM Kit (available May 1990)	●	●	●	●	●	
Macintosh Display Card DRAM Kit	●	●	●	●	●	
Apple Universal Monitor Stand	●	●	●	●	●	

[1] Requires installation of appropriate Apple display card or third-party equivalent.
[2] The Macintosh IIci has a built-in video port, and therefore a display card is required only for the Apple Two-Page Monochrome Monitor. For complete information on the built-in video capabilities of the Macintosh IIci, contact your authorized Apple reseller.

Printer Software

LaserWriter	• Laser Prep 5.2 • LaserWriter Driver 5.2*
LaserWriter Plus	• Laser Prep 5.2 • LaserWriter Driver 5.2*
LaserWriter IIsc	• LaserWriter IIsc Driver 1.1
ImageWriter	• ImageWriter 2.7 (for direct-connect printers)
ImageWriter II	• AppleTalk ImageWriter 2.7 (for AppleTalk-connected printers) • ImageWriter 2.7 (for direct-connect printers)
ImageWriter LQ	• LQ AppleTalk ImageWriter 2.0 (for AppleTalk-connected printers) • LQ ImageWriter 2.0 (for direct-connect printers)

* LaserWriter 6.0 is available for support of color PostScript printers, and will improve halftone printing on monochrome PostScript devices. Contact an authorized Apple reseller for details.

Networking & Communications Software

Access II	• Version 1.1.3
AppleShare	• AppleShare Print Server Version 2.0.1 • AppleShare File Server Version 2.0.1
Apple File Exchange	• Version 1.1.2

Printer Upgrades

	ImageWriter II	ImageWriter LQ	LaserWriter	LaserWriter Plus	LaserWriter IIsc	LaserWriter IINT	LaserWriter IINTX	
LaserWriter IINTX 1MB Mem. Exp. Kit							•	**Memory Expansion**
LaserWriter IINTX 4MB Mem. Exp. Kit							•	
LaserWriter Plus Kit (ROM Upgrade for LaserWriter)			•					**Logic Board Upgrades**
LaserWriter Plus Kit (ROM Upgrade for LaserWriter Plus)				•				
LaserWriter IINT Controller Card					•			
LaserWriter IINTX Controller Card					•	•		

Miscellaneous Peripheral Operating Software

AppleFax Modem	• AppleFax Version 1.2 (with System 6.0.2 or greater) • AppleFax Version 1.1 (with System 5.2)
AppleCD SC	• Macintosh CD Setup Version 2.0.1
Apple Scanner	• AppleScan™Version 1.02 • HyerScan™Version 1.0
Apple Tape Backup 40SC	• Version 2.01

Developer Software Tools

These tools can be ordered from APDA. Phone 1-800-282-APDA.

MacWorkStation	• MacWorkStation Version 3.1
Macintosh Programmer's Workshop (MPW®)	• MPW 3.1
MacAPPC	• Version 1.1
MacAPP®	• Version 2.0b9
Macintosh Allegro Common Lisp™	• Version 1.3
ResEdit	• Version 1.2
Macsbug	• Version 6.2
MPW C++	• Version 3.1d1
CL/1 Developer Toolkit for Macintosh	• Version 1.1
Macintosh Communications Toolbox	• Version 1.0

Many hardware upgrades have configuration prerequisites, and require installation by an authorized Apple service provider.

For complete information regarding any Apple upgrades or updates, contact your authorized Apple reseller or an Apple sales representative. For the location of the reseller nearest you, call: 1-800-538-9696.

Current Apple Upgrades and Updates

An **upgrade** enhances features of existing hardware or software. Generally, an upgrade involves a fee, and any additional Apple hardware must be installed by an authorized Apple service provider.

A software **update** consists of enhancements, fixes, or patches to software. An update to Apple software is handled through an authorized Apple dealer or your Apple sales representative.

Following is a summary of the Apple upgrades and updates currently available for Macintosh products.

Many hardware upgrades have configuration prerequisites, and require installation by an authorized Apple service provider.

Macintosh 128K, 512K Upgrade to Macintosh Plus

Owners of Macintosh 128K and Macintosh 512K computers can upgrade to the Macintosh Plus. The upgrade consists of the Macintosh Plus Disk Drive Kit (part number M2516) and the Macintosh Plus Logic Board Kit (part number M2518/A).

Macintosh SE/30 Logic Board Upgrade

Owners of 1-megabyte or 4-megabyte Macintosh SE computers can upgrade to the Macintosh SE/30 by purchasing the Macintosh SE/30 Logic Board Upgrade (part number M0713). Owners who have a 2-megabyte or 2.5-megabyte Macintosh SE must purchase an additional 2 megabytes of memory to use the upgrade. One drive must be removed from systems that have two internal 800K drives. Macintosh System Software Version 6.0.3, required by the Macintosh SE/30, is included with the upgrade.

Macintosh II and IIcx Upgrades

The ROM upgrade for the Macintosh II enables the Macintosh II to recognize more than 1 megabyte of address space on a NuBus card.

Macintosh II users who want to achieve full system equivalence with the Macintosh IIx system can do so by replacing the Macintosh II logic board with the Macintosh IIx Logic Board Upgrade (part number M0271) and the FDHD Macintosh II Upgrade Kit (part number M6051).

Macintosh IIcx users who want to achieve full system equivalence with the Macintosh IIci can do so by purchasing the Macintosh IIci Logic Board Upgrade (part number M0295LL/A).

Macintosh IIfx Logic Board Upgrade

The Macintosh IIfx Logic Board Upgrade allows existing Macintosh II and IIx users to upgrade to the higher-performance capabilities of the Macintosh IIfx. A Macintosh IIfx accessory kit, consisting of System Software 6.0.5, HyperCard 1.2.5 software, and manuals, is included with the logic board upgrade. Macintosh IIfx DRAM must be purchased separately. To purchase the Macintosh IIfx Logic Board Upgrade use part number M0375LL/A.

LaserWriter II Upgrades

To upgrade the LaserWriter IIsc printer to the LaserWriter IINT, purchase the LaserWriter IINT Controller Card (part number M6009). To upgrade the LaserWriter IIsc or IINT to the LaserWriter IINTX, use the LaserWriter IINTX Controller Card (part number M6004).

LaserWriter to LaserWriter Plus (LaserWriter Plus Kit)

To upgrade the LaserWriter printer to a LaserWriter Plus, an authorized Apple service provider installs 1 megabyte of ROM. The customer then installs the new screen fonts using the printer installation disk (supplied).

LaserWriter PostScript Upgrade Program (LaserWriter Plus Kit)

To upgrade LaserWriter Plus ROMs to PostScript version 47, an authorized Apple service provider installs the LaserWriter Plus Kit.

LocalTalk PC Card ROM Upgrade

Apple has revised the ROM on the LocalTalk PC Card to upgrade the ROM Checksum. This upgrade improves compatibility with various software packages, and is available free of charge.

AppleScan Version 1.0.2

In addition to fixing a number of minor bugs, AppleScan™ 1.0.2 offers more control over Preview, improved compatibility with the AppleFax Modem, and improved transfer of PICT files. Version 1.0.2 of the AppleScan software is available free of charge.

AppleFax Firmware Version 1.2

AppleFax Firmware 1.2 fixes specific incompatibility problems with some Group 3 facsimile machines and certain phone systems, particularly Private Branch Exchange (PBX) phone systems. Version 1.2 of the AppleFax firmware is available free of charge.

AppleFax Software Version 1.2

Version 1.2 of the AppleFax Modem application and the AppleFax Modem Resource contains a number of improvements over Version 1.1, including compatibility with System Software 6.0.3, an end to "character collisions," and improved performance of the "in care of" feature. Version 1.2 of the AppleFax software is available free of charge.

MacTerminal Version 2.3

This MacTerminal software update is available free of charge. The new version features full MultiFinder software compatibility and an improved user interface.

Claris Software

For information about upgrades and updates to the Claris MacWrite, MacPaint, MacDraw, and Mac-Project programs, please contact:

Claris Corporation
P.O. Box 526
Santa Clara, CA 95052
1-800-544-8554

50

Macintosh Technical Bulletin

Mention of third-party products is for informational purposes only, and constitutes neither an endorsement nor a recommendation. All product specifications and descriptions were supplied by the respective vendor or supplier. Apple assumes no responsibility with regard to the selection, performance, or use of these products. All understandings, agreements, or warranties, if any, take place directly between the vendors and the prospective users.

Technical Bulletin Subscriptions

Apple Technical Bulletins are bimonthly publications designed to provide timely and useful technical information to Apple II and Macintosh users, particularly those who provide technical support to other users. Articles about new products, compatibility and connectivity issues, "power user" features, and product updates and upgrades help you use your Apple hardware and software more effectively and efficiently. Two editions are available, for an annual subscription price of $129 each: the *Apple II Technical Bulletin* (order number B0134LL/A) and the *Macintosh Technical Bulletin* (order number B0133LL/A). Each edition is published six times a year. Subscribers also receive the full text of each issue on disk. A storage binder is included.

Apple Technical Bulletins are also available as part of the Apple Software Update Program. For more information, contact your authorized Apple reseller or Apple sales representative.

Corrections:
Technical Bulletins,
March–April 1990 (Issue 9)

The article titled "CL/1 Update" incorrectly listed the following software as being supported by CL/1 Version 1.1:
A/UX Operating System 1.0–1.1
CL/1 Server for A/UX
Informix for A/UX

A/UX is not currently supported by CL/1.